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REVIEW OF THE AVAILABLE LITERATURE OF THE PHARYNX AND PHARYNGEAL SURGERY FOR 1956.*

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ANATOMY.

Boyd[1] reports his observations on the human pharyngeal hypophysis. He describes it as a derivative of the pharyngeal extremity of Rathke's pouch. Its structural features closely resemble those of the adenohypophysis. It was found in 53 human embryos and fetuses. This pharyngeal hypophysis grows during prenatal life and is usually highly vascular. In silver impregnated material nerve fibers derived from branches of the sphenopalatine ganglion could be followed into the pharyngeal hypophysis. Boyd's observations and a survey of the literature suggest that the pharyngeal hypophysis is constantly present in man; however, there is no evidence that it possesses any normal function.

In an interesting introduction to an article on buccopharyngeal cancer, Lederman[2] discusses the morphological considerations of the upper respiratory tract and presents not only descriptive anatomy of the oropharynx but comparative anatomy as well. He subdivides the oropharynx into three

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parts: *1.* buccal; *2.* oropharyngeal, and *3.* laryngopharyngeal. Each of these subdivisions is satisfactorily described and illustrated.

BACTERIOLOGY.

According to Holloway and Scott,[3] there has been a steady increase in the incidence of antibiotic-resistant staphylococci from hospitalized patients and an increase among hospital personnel. Cultures were taken from nursing personnel, hospital personnel who had no contact with patients, and industrial employees. The incidence of staphylococcal carriers among all three strangely was approximately the same; however, the incidence of antibiotic-resistant strains was extremely high among nursing personnel, less so among personnel with no patient contact and lowest among industrial employees. The cases of wound infection were of staphylococcal antibiotic resistant organisms.

DIAGNOSIS.

Gay and Wilkins[4] point out that visibility of the structures of the neck is poor with conventional fluoroscopy. With the development of amplification, however, fluoroscopy has assumed a much more important role in the evaluation of laryngopharyngeal function and disease. The healthy and diseased vocal cords, the subglottic space, the thyroid cartilage and the laryngeal soft tissues may be carefully studied. Farther up, the pyriform sinuses and the retrolaryngeal and retrotracheal spaces may be carefully examined. Fluoroscopy with the image amplifier is of help in the determination of the degree of involvement, in localization of the growth and in the final analysis of the extent of radical excision to be performed in a proved case of cancer.

ACHALASIA.

Nix[5] reports three cases of cricopharyngeal achalasia. He defines this condition as one characterized by neurogenic imbalance with dilatation of the hypopharynx and spasm of the cricopharyngeal muscle. The first stage of deglutition is voluntary contraction of the muscles of the tongue forcing

the bolus from the oropharynx. The second stage is elevation of the larynx with involuntary constriction of the pharynx forcing the bolus into the esophagus, and the third stage is involuntary contraction of the circular fibers of the esophagus propelling the bolus into the stomach. Cricopharyngeal dysphagia is primarily a disorder of the second stage of swallowing.

In two of the three cases reported, bilateral abductor paralysis followed thyroidectomy. In addition to the usual difficulty in respiration each patient experienced difficulty in initiating deglutition.

Nix reminds us that section of the inferior laryngeal nerves results in paralysis of the inferior constrictors of the pharynx. As a result the patients experience difficulty in elevation of the larynx to initiate swallowing. Roentgenograms showing ballooning and apparent lengthening of the hypopharynx with retention of the bolus in the valleculae and the pyriform fossa are pathognomonic. In one case Nix describes successful transplant of the digastric muscle by attaching the anterior and posterior bellies of both digastric muscles to the thyroid cartilage.

PERFORATION.

In a discussion on esophageal and pharyngeal perforations, Barrett[6] refers to three unusual cases of pharyngeal perforations, two of which had been reported in 1944. In both of these a general anesthetic had been given, to do a bronchogram in one child and to remove an acutely inflamed appendix in the other. After a curved metal airway had been inserted into the pharynx, oxygen, bubbled through ether or chloroform, was administered into the airway. After a while the anesthetist noticed that the eyelids and face had become puffy, and within a few minutes the head, neck and trunk were grossly distorted by surgical emphysema. The first child died of asphyxia, but the second was saved by aspirating the air from the root of the neck and maintaining an airway by intubation. At autopsy a small laceration of the mucous membrane was found. It was presumed that the gas, emerg-

ing from the airway with unnecessary force, had penetrated under the mucous membrane and spread.

The third case, a girl, aged two years, had put some wire hair grips in her mouth and choked. The hair grip was seen to be lying below the diaphragm in the radiograph of the upper abdomen. At laparotomy nothing abnormal was found. In subsequent films the wire had moved into the chest and lay inside the right ventricle, from which it was successfully removed. Barrett offered the following explanation: the wire, impacted in the pharynx, had been forcibly ejected through the wall of the pyriform fossa into the lumen of the adjacent jugular vein, as the baby coughed; it had then fallen through the right atrium into the inferior vena cava, and during the laparotomy it had been carried up into the right side of the heart as a venous embolus.

DIVERTICULA.

Oñate and deAll[7] present a complete review of the early history of pharyngeal diverticula starting with Ludlow's report in 1764. They then discuss the various theories responsible for the development of diverticula. Symptoms and surgical technique are described, but nothing new is added. Eight cases are reported briefly.

Lateral pharyngeal diverticula are rare. Kaufman[8] reports the case of an elderly patient in whom such a congenital anomaly was demonstrated roentgenologically. A classification of pharyngeal diverticula is presented.

Solis-Cohen and co-authors[9] report the case of a patient with the unusual findings of multiple esophageal and pharyngeal diverticula and a hiatal hernia of the esophagus. They attribute this unusual combination to congenital muscular weakness.

Harris[10] presents an interesting article on the surgical approaches in the treatment of pharyngoesophageal diverticula. He discusses three types of surgical management: *1.* Invagination technique of repair; *2.* two-stage approach, and *3.* one-stage repair. After describing the anatomic development of diverticula, Harris discusses the merits of each

surgical approach and presents his views. Good diagrammatic illustrations are included.

Harrison[11] expresses displeasure at the amount of space devoted in recent literature to pharyngo-esophageal diverticulectomy. He calls attention to the simple, effective operation of endoscopic diathermy division of the septum between the pouch and esophagus. He believes that the external operation for excision of the pouch is fraught with many difficulties, including the risk of mediastinitis, despite antibiotic therapy. In the early development of the diverticulum, Harrison advocates dilation of the esophagus and reports relief.

During dissection of the neck of the diverticula, Kay noted a hypertrophied band of circular muscle just distal to the mouth of the diverticula. Mosher and Dohlman had previously advocated division of this hypertrophied muscle or septum between the esophagus and diverticulum.

In a discussion on indications Harrison advocates endoscopic coagulation diathermy division of the opposing walls of the diverticular sac and the esophagus, including the hypertrophied cricopharyngeus muscle. This will permit the contents of the sac to escape into the esophagus. The technique of diathermy division is well described and views of specimens are presented.

Harrison reports in detail cases of five patients recently operated upon endoscopically by division of the common wall with good results in all. Since these reviewers have never seen the procedure, we prefer not to comment on its merit; however, results of the external approach are so good that we are reluctant to accept a new procedure.

In an interesting and thorough article, Sweet[12] discusses his experiences in the surgical removal of 67 pharyngo-esophageal diverticula and 10 pulsion diverticula of the lower esophageal segment. As might be expected, regurgitation of previously swallowed material was the most frequent complaint; however, patients had transitory periods of esophageal obstruction due to the pressure exerted by large pharyngo-esophageal diverticula. Several patients were considerably annoyed by gurgling noises during deglutition, usually of

liquids. In commenting briefly on some of the technical difficulties encountered, Sweet expressed the belief that there is little danger of injury to the recurrent laryngeal nerve. Diverticula of the lower end of the esophagus are essentially the same anatomically as those arising at the upper end of the esophagus; however, because of their location, they are technically more difficult to manage. In Sweet's patients the main symptoms caused by these diverticula were pain and dysphagia. The results obtained in the series of pharyngo-esophageal and epiphrenic diverticula were universally good. The surgical technique used was the one-stage method described by Sweet ten years ago.

Pulsion diverticulum of the hypopharynx is a protrusion of mucosal and submucosal layers of the pharynx between the transverse fibers of the cricopharyngeus and the oblique fibers of the inferior constrictor muscle of the pharynx. Brintnall and co-authors[13] believe that the most attractive theory of origin postulates incoordination of deglutition with failure of the cricopharyngeus to relax in a manner appropriate to the second phase of swallowing. The weakest area of the pharynx (Killian's dehiscence) would be especially vulnerable to the abnormally increased intrapharyngeal pressure thus produced. Protrusion of the mucosa and diverticular formation would be expected in this area of weakness, especially in the elderly. The symptoms of pulsion diverticulum are related to the size of the hernial sac. Preoperative esophagoscopy is important to remove solid material from the sac and to determine whether the sac is inflamed or ulcerated. The one-stage procedure is ordinarily preferred. Staged operations are indicated if there is a threat of infection, the patient's nutritional state is so poor that healing of tissue is likely to be delayed, or there exists a contraindication to anything more than simple elevation of the tip of the diverticulum. The surgical technique is well described. These authors prefer the one-stage operation with a transverse incision.

DISEASES.

Riggs'[14] experience with management of 454 patients having benign nasopharyngeal disease has convinced him of the

efficacy of surgical treatment in indicated cases. The pathologic conditions found in this group of patients included hypertrophied infected lymphoid tissue, nasopharyngeal cysts or abscesses, and infected bursae. Riggs emphasizes the fact that surgical treatment should be employed only after nonsurgical measures have failed to alleviate symptoms.

The sensation of a lump in the throat is a rare symptom of neoplasm of the pharynx and larynx, according to Mill.[15] Of the patients complaining of a lump in the throat, two-thirds had pus in the antra on lavage. Some of these patients do have an anxiety neurosis, but sinus infection should always be ruled out before such a diagnosis is made. Mills believes that if the sinuses were thoroughly examined in more of these patients complaining of a "lump" in the throat, more people would be cured of a genuine complaint and less labeled neurotic.

The retropharyngeal space frequently receives the attention of the endoscopist because it is the area first involved in mediastinitis after a perforation of the cervical esophagus. Although inflammatory involvement of this potential space is not uncommon, it is exceedingly rare to find it distended with blood. Fuller, Hirschboeck and Labree[16] report such a case. An 82-year-old woman was brought into the hospital because of acute dyspnea necessitating emergency tracheotomy. She had fallen 20 hours before admission. After seven hours pain developed in the left side of the neck together with severe, progressive swelling. Pronounced widening of the retropharyngeal space was noted in the roentgenogram. Because of the history, trauma and tenseness of the swelling, this was assumed to be due to hemorrhage. A few days later mediastinotomy was performed and 300 cc. of clotted blood were evacuated; symptoms promptly subsided.

Glaser and associates[17] state that in man streptococcal infections characteristically involve the pharynx, and there is slight evidence that the site of the infection may bear a relationship to the genesis of rheumatic fever. They attempted to simulate these infections in rabbits.

In rabbits with single infections of the pharynx, cardiac

lesions developed in only 26 per cent; however, in those having repeated streptococcal infections cardiac lesions developed in six out of seven animals. There was no evidence of bacteremia, only histologic evidence of recent myocardial involvement. The implications of these findings as compared with non-suppurative sequelae in man are discussed.

Elliott[18] states that most patients complaining of pharyngeal dysfunction will be found to be suffering from psychologic or medical rather than neurologic disorders. He briefly discusses these conditions. The neurologic conditions responsible for production of various types of pharyngeal paralysis are then considered. Disorders affecting the pyramidal tracts or the lower motor neurones are responsible for most neurologically caused pharyngeal symptoms, and Elliott believes that the usual cause of pharyngeal spasm is anxiety neurosis. This is a splendid review of the neurologic conditions responsible for paralysis of the pharynx.

On routine physical examination of a baby three days old, Florman and Bergher[19] found an unusual appearing pharynx, which contained four to five yellowish-white papulovesicles on the tonsillar pillars and soft palate. These vesicles frequently broke into ulcerations, but in spite of this the infant did not appear ill. Careful laboratory investigation was instituted, and the usual precautions were observed. During a period of four months, 20 per cent of full term infants were found to have this type of lesion in the mouth. In spite of all efforts the etiology remained unknown.

Harman[20] considers two major diseases that cause pharyngeal paralysis, the first of which is myasthenia gravis. He admits that at times the diagnosis is difficult, particularly for those who see only an occasional case. At some time the pharyngeal muscles of the patient with myasthenia gravis are affected. Pharyngeal palsy is the first symptom in about one-fifth of the cases. The frequency with which this muscle is paralyzed has been made the basis of a diagnostic test which consists of showing radiologically that movements of the pharynx return to normal under heavy doses of neostigmine.

The second major disease causing paralysis of the pharynx is dermatomyositis. This disease is not common, and Harman admits that its clinical features are still obscure.

Harman discusses briefly two conditions that may simulate paralysis. At times it may be difficult to be certain that the pharynx is paralyzed, especially if it is mild and symmetrical. Paralysis may often be suspected in cases of dysphagia. Iron deficiency is a common cause of such dysphagia and xerostoma is a common degenerative change of old age that causes difficulty in swallowing.

Keogh[21] reminds us that the functions of the pharynx are respiration, deglutition and speech. The *modus operandi* of each is thoroughly discussed and the clinical problems involved are considered. Keogh tells us just what occurs when paralysis affects the nasopharyngeal, oral, esophageal and laryngeal sphincters.

Watson and Kerim[22] present an intensely interesting article on parasitic laryngopharyngitis peculiar to the Levant States, where it is known as "halzoun". This condition was first described in 1904 by Khoury. Symptoms develop from a few minutes to one hour after ingestion of the raw liver of goats or sheep. These include severe pain, and edematous congestion of the soft palate, uvula, tonsils, larynx, Eustachian tubes, nasal passages, conjunctiva, and lips. Dyspnea, dysphagia and dysphonia commonly occur. Systemic symptoms are conspicuously absent. Halzoun is contracted by ingestion of raw liver containing very young specimens of "Fasciola hepatica," which attach themselves to the pharyngeal mucosa and produce purely local symptoms, probably by the injection of an irritant and vasodilatory secretion into the attachment wound. Severe symptoms have caused death. There is no specific treatment. An emetic producing vomiting seems to dislodge these parasites from their attachment to the pharyngeal mucosa and seems to be the most effective treatment. Watson and Kerim investigated 23 cases of halzoun and present a graphic description of their observations. Among these there were two cases of severe pharyngitis caused by pharyngeal leech infestation caused by drinking raw spring water. This is a most interesting and informa-

tive article which should be read in the original to be fully appreciated.

Duncan[23] reports the gratifying use of vitamin A therapy in atrophic conditions developing in the nasopharynx or pharynx secondary to a similar nasal condition. A number of patients were treated with a preparation containing 100,000 units of vitamin A in oil given intramuscularly. A course consisted of six injections at weekly intervals. Oral administration of Vitamin A was unsuccessful. Four patients treated by injection noticed improvement in the sense of smell. These intramuscular injections are painful. Eighteen of the 20 patients treated showed improvement.

Colman[24] reports the case of a hemophiliac in whom secondary hemorrhage developed into the tonsillar pillar, lateral pharyngeal wall and pyriform fossa and false cords. The main symptoms were dyspnea from an inadequate air way and dysphagia. The patient was treated conservatively with antihemophilic plasma. Other cases involving the tongue, larynx and pharynx are reported from the literature.

Townsend[25] reminds us that the retropharyngeal space is subject to bacterial invasion from the nasopharynx and from the cervical vertebrae, each mode of invasion producing its own characteristic clinical picture. Since the advent of chemotherapy, abscesses of the retropharyngeal space have become rare, but Townsend pointed out that in recent case reports the clinical picture is the same as described in the last century. Townsend reported a case of a child five years old in whom a sore throat, a stiff neck and inability to extend the head developed. A large retropharyngeal mass, obliteration of the normal cervical lordosis, and subluxation of the second cervical vertebrae on the third were noted in the roentgenogram. Incision and drainage resulted in prompt relief. It is intimated in this article that antibiotics probably masked symptoms.

Mounger[26] presents an interesting article on the pharyngeal manifestations of systemic diseases. He first reviews the anatomy of the pharynx and then discusses systemic diseases that produce pharyngeal disturbances. The paper is rather

lengthy in spite of the fact that each disease is discussed briefly. The subject is well covered, and it is practically impossible to abstract it adequately. Those interested should read the article, as too few papers are written on pharyngeal problems.

DEAFNESS.

Adams[27] found tubal dysfunction to be a common condition in childhood and the commonest cause of social and educational deafness. Of an average of 250 patients seen each year requiring excision of adenoids and tonsils for the relief of tubal dysfunction about 20 require irradiation for continuing deafness. The negative pressures characteristic of the condition usually recover spontaneously in time, but the hearing losses in some patients are the result of secondary changes in fenestral, end organ or neural function in the cochlea.

SURGERY.

For years the pterygoid area of the oral cavity has been considered relatively inaccessible, awkward to approach and difficult to expose. Conley[28] considers the intra-oral approach to this area by either sharp dissection or cautery excision to be encumbered by limited exposure and danger of hemorrhage that is difficult to control. He believes that the external approach to the pterygoid area affords ample exposure and normal control of bleeding. The anatomy of this region is described in detail. The indications for the surgical approach to the pterygoid area are discussed, and the external surgical approach, which Conley has been using successfully, is described. He uses an incision starting high up in the region of the temple, descending just anterior to the ear, and at the angle of the jaw, it follows the lower portion of the mandible to a point about even with the angle of the mouth. The incision is made to rise and join the angle of the mouth. Conley has the facility of making a difficult procedure sound technically easy, and it probably is easy for a master dissector such as he; to others it must present difficult problems. All interested in such surgical procedures should read this article.

BENIGN TUMORS.

Hoch[29] defines craniopharyngiomas as benign pituitary tumors that arise from Rathke's pouch. The diagnosis is made on the basis of endocrinologic, ophthalmologic and roentgenographic findings. These tumors may be treated medically, surgically or by irradiation. Of the two surgical approaches, transfrontal craniotomy and endonasal sphenoidostomy, Hoch believes that the latter approach has definite application in the treatment of cases such as the one he reports in a 35-year-old Negro. Two transfrontal craniotomies had failed to prevent continued enlargement of the tumor and involvement of cranial nerves, but recovery of the involved nerves followed endonasal sphenoidostomy.

Rao[30] reports an interesting case of chondroma of the nasopharynx, discovered when an 18-year-old man sought relief for blockage of the right nostril and dullness in the right ear. The patient was conscious of fullness in the throat. On examination an apparently lobulated tumor filling the right side of the nasopharynx and choana and invading the right lateral wall was seen. The mass felt hard. Surgical removal was uncomplicated, and the pathologic report was chondroma.

Neurilemmomas of the parapharyngeal region are rare. Gore, Rankow and Hanford[31] report four such cases recently seen. In the parapharyngeal region the tumor usually arises from the vagus or cervical sympathetic nerves. These lesions characteristically are slowly growing, solitary, benign tumors. They can occur in any cranial sympathetic or peripheral nerve, but the commonest sites are the head and neck. In a review of the literature Gore and associates found 47 cases, two-thirds of which appeared in the European literature. The locations and appearance of the tumor are considered.

Marshall and Bradford[32] state that tumors of nerve sheath origin are uncommon in the pharynx. The first such case reported in the United States is that of Figi in 1933. These tumors are called neurilemmomas or Schwannomas. They occasionally involve the cranial or sympathetic nerves and commonly affect the acoustic nerve. The pharyngeal tumors

usually are found in the lateral or posterolateral wall. Biopsy can be performed from within the pharynx, but because of the possibility of severe hemorrhage, surgical extirpation through an external curved incision from the mastoid process to the submental area below the mandible is advised. Marshall and Bradford report successful extirpation in one patient.

Arneaud[33] reports a case of neurilemmoma of one retrotonsillar region in a Negro man 39 years old. The tumor was successfully removed. The pharynx is a rare site for this type of tumor, but these tumors are not nearly so rare in other parts of the body as one is led to believe, mainly because of failure to report them.

Neurilemmoma of the pharynx is an exceedingly rare benign tumor that is usually encapsulated and extremely radioresistant. Surgical removal is usually recommended. Marcial-Rojas and Picó[34] report successful removal of such a tumor from the lateral pharyngeal wall of a Puerto Rican mulatto via an intra-oral approach.

Kirchner and Shedd[35] report a case of a large Schwannoma in a woman 55 years old. It was located in the lateral pharyngeal wall and extended upward to the level of the Eustachian orifice, across the midline of the nasopharynx. It could be palpated as a firm mass behind and below the angle of the mandible. Both the retropharyngeal and parapharyngeal portions of the tumor were accessible through the external incision so that a combined approach was not necessary. Despite its large size the tumor was removed in one piece, without undue stretching of blood vessels and nerves, by ligating and dividing branches of the external carotid system and mobilizing and displacing the nerves. Adequate exposure was obtained by retraction of the mandible laterally. The vocal cords moved normally at the end of the operation, and there was no evidence of edema, so that tracheostomy was not necessary.

Reynolds and Groves[36] classified choanal polyps into three groups from a study of 16 cases: *1.* Solitary antrochoanal polyp arising from the antrum; *2.* solitary polyps arising from

other sinuses, and *3.* choanal polyps, which is merely the hindmost of multiple ethmoidal polyps.

Radiographic appearances may help in the diagnosis of origin of the polyp and the sinus involved. The views showing this to best advantage are the lateral occipitomental and submental. This is one more adjunct in the overall means of diagnosis of polypoid degeneration of the sinus mucosa and the presence of polypi in the nasal meati and choani.

Belal[37] reports a case of angiofibroma of the nasal septum in a woman 40 years old. The tumor was removed by snare followed by galvanic cauterization of the base.

Marchetta and associates[38] point out that although juvenile nasopharyngeal fibromas are histologically benign tumors, radical excision sometimes becomes necessary because of recurrent attacks of severe epistaxis and beginning facial deformity. They cite a case of a patient who had numerous episodes of hemorrhage and several unsuccessful conventional surgical attempts at removal. A radical operation, in which the tumor was approached through an incision anterior to the ear and beneath the angle of the mandible, including section of the mandible, afforded adequate visualization and made possible removal of the tumor.

Tapia Acuña[39] briefly discusses all aspects of juvenile fibroma of the nasopharynx gained from the records of 70 patients with this diagnosis seen at the General Hospital of the City of Mexico. He considered the treatment of choice to be surgical, having obtained only fair results from roentgenotherapy and cauterization. The surgical approach may be retropalatine, transpalatine, nasal or transmaxillary, depending upon the size, portion and attachment of the tumor.

Takashi[40] reports three cases of unusual tumors, two of which were in the ethmoidal sinus and do not concern this review. The third was a ganglioneuroma of the pharynx. It had caused a "sensation of stoppage of the nose and of heightened pressure in the ear on both sides, but without disturbances of deglutition or of phonation." It was successfully excised, and the patient had no further difficulties.

MALIGNANT TUMORS.

Lawley[41] reviews the literature on cranial nerve lesions in nasopharyngeal carcinomas. She presents observations on 185 cases of nasopharyngeal carcinoma seen in the Civil General Hospital, Singapore, from 1947 to 1955. Eighty-nine of the patients had cranial nerve lesions. In 48 per cent of the cases there was evidence of damage to the cranial nerve. The abducens and trigeminal nerve were the most frequently involved.

In planning a radical surgical operation on the pharynx, the surgeon must analyze both the excisional and reconstructive phases of the operation. Conley[42] states that excisional surgery for cancer must be without compromise, and occasionally a pharyngotome is mandatory. In approximately 20 per cent of patients undergoing radical excision for malignant tumors of the pharynx with primary closure, a fistula develops. Recognition of a poor tissue bed, as well as other causes for the development of fistula, is considered. Conley describes four types of fistulas occurring as a complication of operations on the neck, and describes and illustrates their surgical correction, including use of local tissue flaps and skin grafts. He also describes the repair and healing of wounds. This is an excellent article on a difficult problem presented by an authority on the subject.

According to Jean Leroux-Robert,[43] cancer of the hypopharynx may be treated surgically, by radiation, or by a combination of these. The tumor usually originates in the pyriform sinus and more rarely on the posterior wall. Those arising on the posterior wall are best treated by a combination of surgical excision and radiation. Cancer of the posterior pharyngeal wall is treated essentially by radiation. Leroux-Robert and Ennuyer classified cancer of the pyriform sinus according to the site of origin, and they pointed out that therapeutic indications differ according to location within the pyriform fossa, the anatomic character and presence or absence of clinical metastatic lymph nodes. The six classifications of cancer arising in the pyriform fossa are considered individually and recommendations are offered for each.

Rowland[44] reports the case of an elderly man seeking relief from blockage of one ear. Failure to find any blockage in the external canal and Eustachian tube prompted further investigation. An enlarged, tender gland was palpated at the angle of the left jaw, and no abnormalities were detected on examination of the nasopharynx. In the roentogenogram made on the same day a definite mass of tissue was seen in the left nasopharynx. The biopsy report of gland tissue of the neck was metastatic lympho-epithelioma. It is difficult to understand why a second biopsy was necessary five days later. Radiotherapy was instituted, and a total of 3000 *r* units was given. Later, Rowland states that deep Roentgen-ray therapy was designed to deliver a tumor dose of between 6500 and 7000 *r* units, but he does not state definitely that the patient received this dosage. At laparotomy a metastatic lympho-epithelioma was found. Unfortunately, early metastasis developed. This type of tumor usually responds favorably to radiation.

Stevens[45] made a study of 35 cases of malignant tumors of the nasopharynx seen at the Cardiff Royal Infirmary between January, 1948, and August, 1954. The incidence of this neoplasm in England has been variously reported as between 0.5 per cent and 2 per cent of all malignant growths. The tumor is common in China and Japan, and in the Canton province of China 25 per cent of all malignant growths occur in the nasopharynx, a possible cause being the common use of smoking kerosene lamps. The study showed that 64 per cent of cases were squamous carcinomas, 10 per cent lympho-epitheliomas and 15 per cent lymphosarcomas. The lateral wall of the nasopharynx was the commonest site of origin in this series, and unilateral deafness with perhaps pain in the ear is the commonest complaint. Stevens stresses the importance of adequate nasopharyngeal examination. Treatment is irradiation. The most radiosensitive growths are lympho-epithelioma, lymphosarcoma and plasmocytoma. The mixed salivary tumors and the squamous cell carcinomas are less radiosensitive. In Stevens' 35 patients 12 are alive.

Burns and coauthors[46] report a case of renal carcinoma metastatic to the nasopharynx in a woman 74 years old, whose

initial symptom was epistaxis. The primary tumor and its pharyngeal metastatic lesion was successfully removed, but the patient returned about two months later with epistaxis and was found to have extensive local recurrence of the nasopharynx. She died about a week later. Permission for autopsy was not obtained.

The problem of management of carcinoma of the hypopharynx and cervical esophagus is discussed in detail by Grimes and Stephens,[47] who believe that surgical treatment offers more palliation and a greater chance of survival than other forms of therapy. They present a statistical analysis of 25 such patients operated upon at the University of California over a period of six and one-half years. The standard Wookey procedure, consisting of removal of the lesion, larynx and cervical esophagus *en bloc*, and staged reconstruction of the esophagus was used; in a number of patients unilateral neck dissection was also done. Seventeen of the patients were dead at the time of the report, two others had recurrences, and six were free of recurrence from one to five and one-half years postoperatively. These figures are discouraging, but they do not express the great measure of relief and comfort afforded these patients for many months by this type of operation.

In a symposium on errors in early diagnosis and treatment of cancer of the upper respiratory tract, Reed[48] states that probably the most common source of error in diagnosis of early cancer of the pharynx lies in the nasopharynx. Although this region is frequently referred to as inaccessible, it should not be considered inaccessible to the otolaryngologist. Proper use of mirrors, the nasopharyngoscope and palate retractors enable the otolaryngologist to visualize the entire nasopharynx.

Reed stressed the fact that probably one of the most common errors committed by otolaryngologists in detecting early cancers of the pharynx is failure to realize the importance of palpation. Palpation should be a routine part of every examination of the patient with unexplained pharyngeal symptoms. In addition, unexplained enlargement of a node demands most careful and minute search of the pharynx and

upper respiratory tract for a primary lesion before biopsy is considered. Reed comments on the fact that many otolaryngologists do not use a local anesthetic sufficiently. In gaggy or sensitive patients the nasopharynx and hypopharynx may be examined more carefully if these areas are partially anesthetized.

Treatment of lesions in the pharynx and nasopharynx resolves into radiation of the primary lesion and excision or radiation of metastatic lesions. Advantage should be taken of supervoltage therapy and rotation technique, if available. Supervoltage therapy has not resulted in a higher percentage of cures than regular 200 k.v. therapy, but it causes fewer cutaneous and secondary reactions. Many patients can tolerate two or three courses of radiation in the event of recurrence.

King[49] states that the composite operation for advanced intra-oral and laryngeal cancer consisting of resection of the structure containing the primary tumor in continuity with its principal deep cervical lymph nodes, is being performed with increasing frequency. If the resection includes a large amount of skin and mucous membrane, repair is difficult because of frequent necrosis of skin flaps. King discusses the causes of fistular development. Prompt repair is urgent. A reasonably rapid method of repair, which has been successful in two cases, is described. This method consists of swinging a flap of skin from the posterior portion of the neck sufficiently long to cover the fistulous opening. This posterior cervical flap has adequate blood supply so that its length does not impair its viability.

The importance of management of oral and pharyngeal carcinoma has been well documented by statistical and clinicopathologic studies. Malignant neoplasms of the mouth and pharynx vary, says Skolnik,[50] in their appearance, clinical course and prognosis in accordance with their site of origin. Significantly, however, they are characterized clinically by the presence of early metastasis to the cervical lymph nodes. Malignant tumors of the tonsils represent about 20 per cent of pharyngeal carcinomas and less than 2 per cent of all carcinomas. Skolnik further states that effectiveness of irradiation of the primary lesion depends upon the histologic picture.

A well differentiated carcinoma is relatively radio-resistant in comparison with an anaplastic carcinoma or a lympho-epithelioma, particularly a lymphosarcoma. Although Skolnik thinks that irradiation is the method of choice, there are instances in which surgical treatment has been effective. A small isolated lesion, with no extensions or complications, can be treated adequately by tonsillectomy. Cervical metastasis secondary to a malignant lesion of the tonsils usually requires irradiation followed by neck dissection. No controversy, says Skolnik, exists as to treatment of cancer of the hypopharynx. Roentgenotherapy accomplishes little. Characteristic of this region is the abundant lymphatic drainage with a high incidence of cervical metastasis. It is this fact that makes it necessary for the surgeon to perform lateral pharyngostomy or laryngopharyngectomy and radical neck dissection on the involved side of the lesion, either in the presence or absence of nodes.

Rhabdomyosarcoma is a highly malignant tumor of mesodermal origin that is exceedingly rare in the pharynx. Pearson and co-authors[51] report a case of rhabdomyosarcoma involving the hypopharynx and larynx which was successfully removed.

In an effort to provide additional relief for six patients with recurrent carcinoma of the nasopharynx, who had previously received external roentgenotherapy, Sooy[52] treated them with septectomy, electrodesiccation and radioactive cobalt. Three of the patients are well and have shown no evidence of recurrence for periods of eight years, six years and nine months, and six years after treatment. One patient died eight months after treatment from extension of cervical metastasis; the other two died within 13 months of treatment. Of 10 additional patients subsequently treated, five died and five were well for periods from six months to four years. Sooy admits that although initial studies indicate that half of the patients treated were benefited, a larger series and longer follow-up period are necessary before valid conclusions can be drawn. Six illustrative cases are presented.

Deatsch[53] reports treatment of 22 patients having carcinoma of the nasopharynx with intracavitary radioactive cobalt

between 1949 and 1954 at the University of California Hospital. He points out that although the results are neither numerous enough to be statistically significant nor old enough to supply data as to five-year survival, they provide interesting information. All patients with local lesions treated in this way are still alive, two as long as five years. Deatsch believes that this suggests that addition of radioactive cobalt therapy may be of greatest value in providing better control of the primary lesion. Twenty-five per cent of the patients treated with radioactive cobalt for recurrence were salvaged.

The method is advocated to supplement rather than replace other methods of treatment, such as external roentgenotherapy or surgical excision of lymph nodes in the neck. The method consists in placing a bead of radioactive cobalt in a Foley catheter through the nose and inside the nasopharynx. To help place the cobalt bead properly a part of the nasal septum is first removed. The bead is left in position for the time calculated to give the desired dosage. It is removed after the catheter is deflated. The patient is then given a full course of external roentgenotherapy.

In a most excellent, extensive and comprehensive article, Lederman[54] discusses the classification and clinical features of buccopharyngeal cancer. Each area in the buccal and pharyngeal cavities where malignant tumors may occur is given consideration and much discussion is devoted to the linguo-tonsillar and palatoglossal sulcus. This article is replete with excellent illustrations of practically all lesions occurring in various locations in the mouth and pharynx. This article is difficult to review adequately, and it should be read to be appreciated.

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UNIVERSITY OF MICHIGAN.

The annual Otolaryngology Conference at the University Hospital, Ann Arbor, will be presented April 17, 18 and 19, 1958, by Dr. A. C. Furstenberg and Staff, Department of Otolaryngology, together with eminent guest lecturers.

Applications may be addressed to the Department of Postgraduate Medicine, University Hospital, Ann Arbor, Michigan.

TRACHEOSTOMY.

V. NEGUS, M.S.,

London, England.

Although at first sight the subject may appear to be beyond the necessity of discussion, yet there are many aspects worthy of consideration.

DEFINITION.

The previously adopted word, "tracheotomy," means cutting or opening the trachea for inspection, for the removal of a foreign body, for the insertion of radon seeds, or for the excision of a simple growth; after the procedure is completed the trachea is closed.

To make a window in the trachea for the temporary or permanent insertion of a cannula is the operation of tracheostomy, just as similar words are used in other regions with reference to gastrostomy, colostomy or jejunostomy; the distinction is perhaps small but worthy of accurate description.

INDICATIONS.

Tracheostomy is occasionally required as a preliminary to operations for the treatment of *congenital stenosis*, which can be dealt with by restoration of the lumen and insertion of a skin graft. *Foreign bodies* should not require opening of the trachea, either for their removal or for lower bronchoscopy. When a vegetable object has caused subglottic edema and swelling tracheostomy may be essential.

For *injuries* a tube may be necessary in the trachea for the relief of urgent dyspnea, or subsequently before an operation for the removal of scar tissue, followed by skin grafting. In some severe cases the tracheostomy must be permanent (see Fig. 1).

Perichondritis following direct injury, or resulting from

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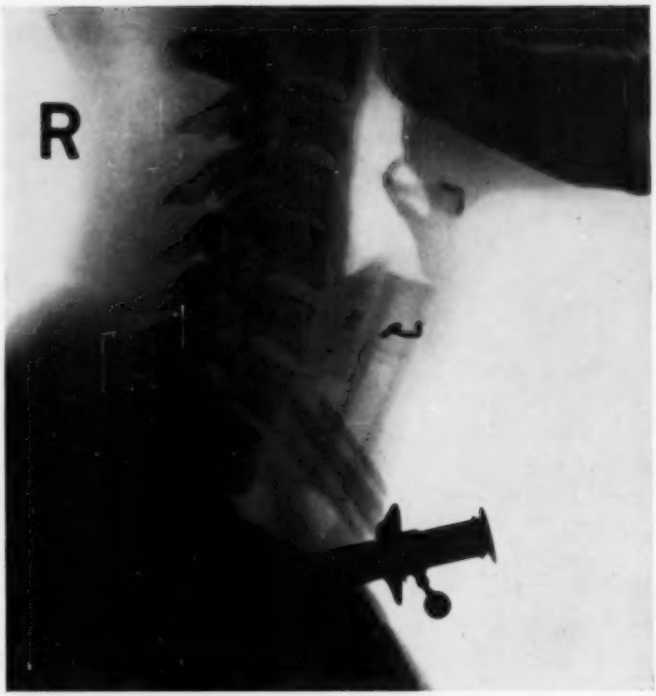

Fig. 1. Tracheostomy for cicatricial stenosis of larynx. Inserted for the relief of obstruction, the cannula was retained during reconstitution of the laryngeal lumen: a plastic tube, covered with a Thiersch skin graft, was placed in position after removal of scar tissue. The plastic tube was held in position by a stainless steel wire.

the irritation of a cannula, inserted at too high a level, may require permanent tracheostomy. This possibility is a warning against dividing the first or second tracheal rings, and against damaging the cricoid. If it is found that in a hurried operation one or the other of these structures has been injured, there should be no delay in transferring the tube to the lower level of the third or fourth ring, or sometimes even through the fifth or sixth ring of the trachea.

Occasionally an obstruction at the level of the glottis, or in the subglottic region, is aggravated by or directly due to

the presence of granulation tissue; improvement cannot be expected without replacement of the cannula at a point well away from the larynx.

Diphtheria is not a frequent indication for opening the trachea; first, because of improved methods of treatment; second, because of the superior advantages of repeated removal of crusts and aspiration of secretions through a direct laryngoscope.

Acute tracheobronchitis, especially in infants, is an indication for tracheostomy, not only for facilitation of respiration but also for the removal of obstructing secretions by aspiration through a suction tube passed through the tracheal cannula.

Poliomyelitis has recently been given an improved prognosis by making a window in the trachea, and inserting a cannula, through which secretions may be removed, with reduced risk of their flooding the lumen and drowning the patient in his own secretions.

A cannula with an inflatable cuffed tube is necessary, if respiration under positive pressure is to be maintained.

Of *simple new growths* the most common to cause obstruction was at one time papilloma, but this seems to be infrequent at the present time in London. In my experience chondroma has more often been the cause of obstruction, with the necessity of tracheostomy as a preliminary to removal of the tumor (see Fig. 2).

Carcinoma affecting the larynx, and occasionally the upper end of the trachea, may require tracheostomy, either as a preliminary to the operation of laryngo-fissure for a limited tumor, or for the relief of obstruction by an extensive growth.

Owing to the good results of teleradiation and the rarity of surgical removal of a limited growth in the majority of clinics, the former indication is rare. Even when irradiation is employed tracheostomy is very seldom necessary if the method is by distance radiation. Interstitial insertion of needles is out-moded since the improvement in the use of a beam in recent years. If employed, there is no necessity for

Fig. 2-A—Chondroma of trachea. Obstruction to respiration, thought before transference to this country to be due to pressure of an aneurysm, was caused by a chondroma almost completely filling the trachea. After insertion of a tracheal cannula at a low level the tumour was removed, with no subsequent disability.

Fig. 2-B—Chondroma of trachea. The hard tumor is shown by tomography to arise from the right wall of the trachea. The patient was referred to me by Sir John Parkinson. Radiographs by Dr. Peter Kerley.

tracheostomy and, in fact, some disadvantage in its performance.

When laryngectomy is indicated, it is usually possible to overcome the effects of obstruction without preliminary opening of the trachea, but in cases of doubt, or in those where a few days' freedom of respiration are required, a tube may be inserted.

Paralysis of the larynx, with narrowing of the glottis, is due to involvement of both recurrent laryngeal nerves. Dyspnoea is usually severe, and the insertion of a cannula is necessary. As to its permanent retention more will be said later.

Urgent necessity for tracheostomy may be judged partly by the observation of stridor when resting, during the day as well as by night. A clinical test of some value is estimation of sodium bicarbonate in the blood plasma. This rises as sodium is withdrawn from combination with proteins and other buffer substances, in an attempt to maintain the constancy of the acid alkali ratio, by combination with a rising CO_2 content, thus keeping the reaction of the arterial blood at a normal level of pH 7.4.

Control of the reaction of the blood cannot be maintained indefinitely if obstruction increases, and eventually anoxaemia occurs with danger to life. The imminence of this possibility may be indicated by the biochemical test.

PHYSIOLOGICAL CONSIDERATIONS.

1. There are *glottic movements* of dilatation at the beginning of inspiration, and of narrowing when expiration commences. The object, in my opinion, is regulation of entry and escape of air in relation to the flow of blood through the pulmonary capillaries. During inspiration much air is required to meet a free circulation of blood, in order to supply oxygen and to remove carbon dioxide. Partial inspiratory obstruction produces some degree of acceleration of the circulation. The greater the resistance the less will be the volume of tidal air, and the greater the amount of blood in contact with the walls of the alveoli.

The two must be balanced for the attainment of maximum efficiency. There is a minor degree of opening of the glottis at times of rest and there is wide dilatation during exertion.

On expiration, partial closure of the glottis helps to dam up blood on the right side of the heart and to prevent its passing through the lungs when there is little fresh air for respiratory exchanges. This mechanism is present in an elaborated degree in cetacea, where there are wide sinusoids in the liver.

2. *Pump action* on the pulmonary circulation assists not only in the respiratory exchanges referred to, but is also of considerable advantage in draining venous blood along the great veins into the right auricle, as a result of reduced intrathoracic pressure during inspiration. At the same time there is dilatation of the pulmonary capillaries, with free circulation from the right to the left side of the heart. The left ventricle, receiving additional blood, pumps more into the arterial systemic circulation, fully charged with oxygen and depleted of carbon dioxide.

Although, on theoretical grounds, insertion of a cannula in the trachea might be expected to produce severe effects on respiratory exchanges; yet, in fact, little disability is felt in the adapted subject. There is no doubt, however, that in some cases the subject of laryngectomy, with a wide open trachea, finds his capability for hard manual labour reduced.

3. *Warming and moistening* of inspired air are disturbed by tracheostomy, since there is no longer the assistance of the nose in this function. Although considerable adaptation occurs after a time, yet at first disability is experienced.

Secretions in the trachea and bronchi tend to be thick, and their drying may lead to the formation of obstructing crusts. This is particularly noticeable after laryngectomy, when the tracheal stoma is wide and is entirely cut off from the pharynx, mouth and nose. The means of avoiding trouble will be considered later. Measurements have been made of the temperature gradient in the normal individual and in the subject for laryngectomy. Normally air reaches a temperature of 34° C. in the larynx, 36° C. in the trachea and 37° C.

in the air sacs and alveoli. After laryngectomy, according to Heyden, the temperature in the trachea is on the average 5.1° C. less than with nasal respiration. Relative humidity after laryngectomy is at a level of 94 to 96 per cent in the trachea and 95 to 100 per cent in the terminal air sacs. After tracheostomy the readings were low in the trachea, which shows the necessity of assistance in humidification.

OPERATION.

The disadvantage of high tracheostomy is well recognized as the cause of perichondritis of the larynx, with subsequent stenosis. There is excuse for inserting the cannula at too high a level in an emergency, but none for leaving it there. At the time of operation, when obstruction has been relieved, and when venous engorgement has disappeared, it is best to move the tube to a lower level, usually at the third or fourth ring of the trachea.

It is desirable to make a round window in the trachea before inserting the cannula, either as a primary measure, or, if dyspnoea is very severe, as a secondary step after making a slit in the tracheal wall. The disadvantage of forcing the tube through a slit is the danger of pushing part of the tracheal wall inwards, with subsequent obstruction. Furthermore, the compressed tracheal cartilage necroses, and may form granulations which organize and cause blockage. And of most importance, it is difficult to re-insert a tube through a slit if it becomes displaced and easy to replace it through an adequate window.

It is advisable to warn the patient's attendants of the danger of slipping of the tube out of the lumen and onto the front of the trachea. A small piece of cotton should be held in front of the cannula if in doubt, and if no air passes the cannula should be removed and the wound held open with a pair of forceps, or a dilator, until tranquil respiration is restored, when the tube can be re-inserted into the trachea without difficulty.

It is sometimes desirable to pass a blunt-ended gum-elastic tube through the larynx before opening the trachea, as a

means of relieving severe dyspnoea; occasionally a bronchoscope may be inserted for the same purpose.

At operation a dyspnoeic patient is embarrassed if made to lie down, partly because the lower thorax cannot expand freely. Personally, I perform tracheostomy under local analgesia, with the patient reclining, the head being supported

Fig. 3.—Position of Tracheostomy. The use of a table that can be tilted, with an adjustable head rest, avoids some of the discomforts of the recumbent position. A sterilizable wheel allows the surgeon to extend the patient's head when desired. On the opposite side of the table there is a sterilized quiver to hold instruments.

by a head rest, which allows of adjustment of position (see Fig. 3).

Another aid to ease of operation is afforded by 80 per cent helium with 20 per cent oxygen, administered through a mask. The lightness of helium, as compared with nitrogen, facilitates diffusion of oxygen into the blood capillaries and increases elimination of carbon dioxide.

The mask must be held firmly on the patient's face without leakage. Blood, which at the beginning of operation is blue

Fig. 4—Tracheostomy cannula. The author's type of tube with expanded outer end, allowing a recessed inspiratory valve to be fitted. In various respects the cannula resembles that of Chevalier Jackson, but it is shorter and with a slightly different curve.

or almost black, becomes pink as soon as this mixture of gas is given.

Type of Cannula.

Although trained in the use of the lobster-tailed Durham's tube, I found certain disadvantages in its use and, therefore,

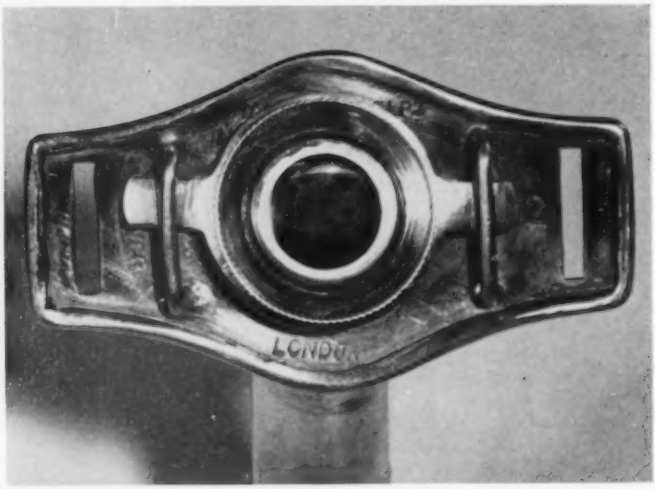

Fig. 5. Valve opening on inspiration. Since it is incorporated in an expanded inner tube, there is no restriction of the lumen.

designed a tube shaped in the arc of a circle, but enlarged at the proximal end (see Fig. 4). This projecting part lies in the groove between the sternomastoid muscles, and can be made larger than the rest, with the advantage that a valve, carried in the inner tube, can lie flush on the surface of the neck (see Fig. 5). This inspiratory flap valve is of great advantage in allowing freedom of speech to patients whose larynx is sufficiently narrowed to require a tracheostomy for inspiration, although allowing expiratory air to escape through the usual channels.

Although the cannula is made in various sizes according to the age and sex of the patient, yet it is as well to check

the correctness of curvature by lateral soft tissue radiographs. It is thereby possible to see whether the tube is so sharply curved as to rub against the anterior wall, or so open as to irritate the posterior wall of the trachea.

In place of rubber tubes, which seem to be preferred by some patients and which are required when irradiation is indicated, plastic tubes seem to have certain advantages; the thickness of the wall and the absence of an inner tube detract from their merits.

ADVANTAGES OF TRACHEOSTOMY.

For temporary use in such obstructive diseases as diphtheria, tracheostomy is, in my experience, preferable to intubation; the latter requires continual skilled supervision, may lead to ulceration and subsequent stenosis of the larynx, and does not afford a sufficiently wide lumen for the expulsion of thick secretions or slough. Opening the trachea is, however, largely superseded by direct laryngoscopy and translaryngeal suction. For repeated suction in acute tracheobronchitis and poliomyelitis tracheostomy is, on the other hand, preferable to peroral suction, since removal of secretions may have to be repeated frequently for many days, in contrast to the temporary embarrassment of diphtheria.

As a permanent measure for the relief of obstruction caused by double abductor laryngeal paralysis, the use of a properly placed and efficiently designed cannula has, in my opinion, some advantages over operations for displacement of one vocal fold. With a tracheostomy tube fitted with an inspiratory valve the individual can inspire freely, and is able to talk with a clear voice (see Fig. 6). I have never yet seen a patient, operated upon by any of many methods, with a clear voice and free respiration; one or the other function must be reduced.

AFTER TREATMENT.

An immediate danger of tracheostomy, not always recognized, but of considerable danger, is *acapnoea*. This results from opening the trachea in a subject of long standing

laryngeal obstruction. Difficulty in maintaining efficient respiratory exchanges shows itself, especially in lack of removal of carbon dioxide. The normal individual, whose CO_2 level is artificially raised by 0.2 per cent, compensates for this abnormal stimulus by an increased lung ventilation of 100 per cent. In the normal individual the level remains constant because of immediate adjustments of breathing. When obstruction gradually increases and is of considerable

Fig. 6. The valved cannula in position to illustrate its inconspicuousness, since it lies flush on the neck between the sterno mastoid muscles.

duration, perhaps over some months, the alveolar CO_2 percentage rises from the normal 5.6 per cent, sometimes to as much as 8.0 per cent; the respiratory center becomes adjusted to this higher level, partly because of increase in buffer substances in the alkali reserve, with maintenance of the acid alkali ratio. The blood reaching the respiratory center is maintained at a constant, slightly alkaline level of pH 7.4.

When obstruction is suddenly released by tracheostomy the increase in ventilation washes out alveolar CO_2 and restores it, in perhaps four or five breaths, to its normal level of 5.6

per cent; but the excessive buffer substances remain and the respiratory center fails to respond to the reduced level of CO_2, which gas is its normal stimulus. During the subsequent period of acapnoea, with cessation of respiration, there is lack of oxygen, but even the severest drop in this gas fails to stimulate the center. In the absence of correct treatment the patient dies after an apparently successful operation.

The correct measures to be taken are to make the patient breathe 5 per cent CO_2 in oxygen, usually known as carbogen, at the first sign of acapnoea and to resort to artificial respiration if breathing is slow in returning. A cylinder of the mixed gases should accompany the patient to the ward, and should be in readiness for several hours.

After operation, suction through a rubber or plastic catheter is the usual preventive measure, and is essentially necessary for the removal of secretions. *Humidification* of inspired air is important, especially in the Winter months, when the cold atmosphere carries very little moisture. When this air, with a low absolute humidity, is warmed in the patient's room or in a ward, the relative humidity, which varies inversely with the temperature, drops to an abnormally low level, perhaps to 20 per cent. To prevent excessive viscosity of secretions and the formation of obstructing crusts, the inspired air should be at a relative humidity of about 60 per cent; at Helsinki, in the wards where tracheostomy cases are nursed, the level is kept as high as 70 per cent.

Cold water atomization is preferable to humidification with a steam kettle, since the moisture with the latter method has a tendency to condense, particularly if the patient is in a tent.

It must be remembered that compressed oxygen is completely dry and, therefore, particular care is required in supplying moisture if oxygen is administered. In some cases of tracheo-bronchitis, or in similar conditions, the secretions are very thick and the addition of a wetting agent to the atomized moisture is of advantage.

When a patient with a tracheotome is out of doors in cold air some precaution must be taken against deficiency

of moisture. A valved tube should not be used, since every inspiration is from the external atmosphere. An open inner tube is inserted with a wire cage over its aperture, covered with six layers of gauze. The gauze is soon warmed and moistened by expired air and acts as an efficient air conditioner.

Decannulation is a well recognized procedure by means of a cork with a groove cut in it, the groove being gradually reduced until the patient can breathe freely through the larynx with the cannula closed.

SEQUELAE.

An individual with a suitably placed and correctly designed cannula can live a normal life except for the necessity of avoiding swimming.

Trouble is caused if the cannula is too highly placed, with subsequent perichondritis; or pushing in of the lip of the tracheal opening owing to neglect of a window may cause stenosis. Bronchitis is usually due to absence of arrangements for warming and moistening the air.

The inner tube is cleaned on necessity, but the outer tube can remain in place for three or four weeks or more. It is easy to change if in the arc of a circle. The patient must not clean the cannula with a wire-brush.

If these precautions are kept in mind the subject of tracheostomy should lead a happy life. In my experience patients are so well satisfied that they refuse operations designed to overcome paralytic laryngeal obstruction.

I am grateful to Mr. Geoffrey Bateman for reading this paper and suggesting various useful amendments.

DECREASED BIO-ELECTRIC POTENTIALS IN THE EARS OF SENILE GUINEA PIGS.*†

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Presbycusis contributes to morbidity rather than to mortality in geriatric practice. Commonly the deterioration in hearing function constitutes a handicap, but is not severely disabling; however, severe deterioration of function does occur, sometimes from presbycusis alone and sometimes when presbycusis coexists with other aural pathology. Careful evaluations of the functional defects indicate that loss of ability to discriminate among complex sounds as well as a loss of sensitivity exist.[1] The pathology observed is ambiguous and suggests that at least two types of lesions,[2] primary in the sense organ and in the neurons of the spiral ganglion, may be responsible. Both the non-lethal character of the disease and the technical difficulties inherent in obtaining adequate temporal bone specimens combine to restrict our understanding of the disease; neither have the potentialities of experimental animals been extensively explored. Schuknecht[2] has reported conditioned behavioral responses to auditory stimuli in the senile cat, along with the pathology observed in the temporal bones, but little else appears in contemporary literature.

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Bio-electric potentials, the nerve action potential (AP) and the cochlear microphonic (CM), have been extensively studied in normal guinea pigs.[3,4,5] The present study represents an attempt to relate these potentials to the pathology observed in the cochleas of senile guinea pigs. The pathology has been described by Covell and Rogers[6] and a preliminary report on the changes in the bio-electric potentials has been made by Pestalozza.[7] Diminished bio-electric potentials in response to high audio frequencies were observed in the ears of truly senile guinea pigs obtained from the colony of Dr. J. B. Rogers. These same ears examined histologically showed varying amounts of degeneration of the organ of Corti and rather consistent loss of the spiral ganglion neurons associated with the organ of Corti at the extreme base and near the apex of the cochlea.

The interpretation of the results of the present experiments depended largely upon quantitative differences in the bio-electric responses. Previous studies of these potentials have dealt largely with qualitative differences. Thus it was necessary to extend our knowledge of quantitative variation of the normal responses to the stimuli used in these particular experiments. In addition to the changes in response which can be attributed to the pathology of senility, other factors can produce variations in response. These factors must include, at least, *a.* normal individual variation; *b.* physiological variables related to the experiment, *e.g.*, mild hypoxia; *c. physical* variables of the stimuli, and *d.* systematic genetic differences between different colonies of experimental animals. Factors *a*, *b*, and *c* could be controlled only statistically in these experiments. Factor *d* was partially controlled by comparing the responses of both young and senile ears from Dr. Rogers' special colony to the normal responses established on the ears from our usual commercial sources.

MATERIAL AND METHODS.

Twenty-eight young (200-300 g.) guinea pigs and two adult (457 g., 600 g.) guinea pigs were procured from our usual commercial source. Seven young and 12 senile guinea pigs were used from the colony of Dr. Rogers. With the animal

under Dial (Ciba) anesthesia (0.5 cc/kg.) a small opening was made in the bulla and a single wire electrode placed on the round window membrane. A reference electrode was placed on the neck wound. A speculum fitted with lugs was sewed firmly in the ear canal and the open end of the speculum seated in a hollow lucite cylinder (length, 75 mm.—internal diameter, 19 mm.). The acoustic stimuli were generated by a Kellog condenser microphone fitted in the other end of the cylinder.

Bursts of pure tones with time of onset of one millisecond were used for the stimuli. The frequencies used (8, 12, 15, 21, 25, 30, 38 Kcps) were chosen to match particular resonances and "plateaus" in the frequency response characteristic of the acoustic system. Since the ear of the guinea pig is "tuned" about an octave above the ear of man[8] the frequency range 8-38 Kcps corresponds approximately to a frequency range of 4-19 Kcps in man. The absolute sound pressure levels generated in this acoustic system could not be measured to our satisfaction; therefore, all results are given relative to normal responses. The quantity measured was the voltage across the condenser microphone source that was required to elicit a three microvolt (μv) response for the AP, CM, and SP at each frequency.

RESULTS.

The range of stimuli required to produce standard three microvolt bio-electric responses from "normal" young ears was as great as 46 db. The larger ranges were usually associated with the higher frequencies. Many different factors undoubtedly contributed to this large "normal" variation.

The CM is produced by the hair cells of the organ of Corti in response to displacement of the basilar membrane by the acoustic stimuli. For a given displacement of the basilar membrane the CM reflects the physiological condition of the hair cells. If the displacement of the basilar membrane is less than usual because of variation in the acoustic stimuli, or because the acoustic pressure is poorly transmitted to the cochlea (a conductive hearing loss), there will be an apparent reduction in the ability of the hair cells to produce CM.

The AP is produced by the neurons of the spiral ganglion. AP can probably be stimulated by either CM or SP, but normally near threshold is dependent on CM. In the presence of normal CM the AP then reflects the overall physiological condition of the neuron population that normally should respond to the test stimulus. We have frequently observed under known conditions of mild hypoxia that the AP is more sensitive to this mild hypoxia than is CM. We infer that occasionally mild hypoxia may escape detection during an experiment and lead to an elevation of the 3 μv threshold for AP. This change would depend only on the hypoxia, and not on any other abnormality of the bio-physical system of the ear.

The source of SP is still unknown, although we strongly suspect that SP is a response of the internal hair cell to displacement. SP is increased by the presence of holes in the bony wall of the cochlea and by mild injury, but is decreased by severe injury. It is a normal response which can be easily measured from the round window membrane of the intact cochlea. In the absence of measureable CM, SP appears to be an adequate stimulus for AP.[9]

We assume that any or all of the uncontrolled variables mentioned above were present in the experiments done to determine the 3 μv thresholds for the bio-electric potential produced both by normal ears and by senile ears. The 3 μv thresholds for AP, CM and SP were examined on 28 ears of 24 apparently normal young guinea pigs. The records of eight ears from eight animals were discarded because of obvious technical difficulties during the experiments. The seventy-fifth, fiftieth, and twenty-fifth percentile values for each measure (AP, CM, SP) at each frequency were established from the remaining 20 ears. Our norms for the 3 μv thresholds of the bio-electric potentials from the senile ears are the quartile values established from the normal young ears.

Several of the uncontrolled variables that could appear in our measures tend to raise systematically the thresholds for the 3 μv responses. Since the distribution of all of the 3 μv thresholds was skewed we infer the presence of these vari-

ables. The threshold for each measure at each frequency which was as many decibels below the median threshold as the most sensitive threshold was above the median threshold was taken as a secondary criterion. Thresholds less sensitive than this we consider surely abnormal.

The medians and distributions of the 3 μv thresholds for 12 ears of seven young guinea pigs from the Rogers colony were not significantly different from our normal control thresholds. We conclude that these guinea pigs at least start life with the same sensitivity to these acoustic stimuli as the animals from our usual commercial source.

The 3 μv thresholds measured on 16 ears of 12 senile guinea pigs fell almost entirely below the twenty-fifth percentile and frequently were below our secondary criteria. The average quartile rating of the seven test frequencies is given in Table I for AP, CM and SP. The differences between the

TABLE I.

Distribution of Thresholds of Sixteen Senile Guinea Pig Ears.

Ear	Age (weeks)	AP	CM	SP	AP-CM
949R	238	4^{7}	4^{4}	4^{5}	4^{4}
949L	238	4^{7}	4^{7}	4^{5}	4^{5}
947R	225	3^{2}	1	2	4^{4}
947L	225	4^{4}	1	3	4^{7}
935R	117	4^{7}	4^{6}	4^{5}	4^{7}
935L	117	4^{7}	3^{2}	3^{4}	4^{7}
934R	118	4^{7}	4^{5}	4^{6}	4^{7}
933R	110	4^{4}	4^{4}	4^{7}	3
933L	110	4^{7}	4^{6}	4^{7}	4^{7}
932R	138	4^{7}	4^{4}	4^{6}	4^{6}
931R	110	4^{5}	4^{2}	4^{7}	3^{5}
928R	103	4^{2}	3^{2}	4^{2}	3^{2}
927R	116	4^{7}	4^{4}	4^{5}	4^{7}
926R	121	3^{5}	2	3^{2}	4^{2}
925R	146	4^{7}	2	4	4^{6}
924R	115	4^{7}	3	4^{6}	4^{5}

The average 3 μv thresholds for seven frequencies were compared to the quartile distribution of the average thresholds for normal young ears. The bold face numbers designate the quartiles:

1—better than seventy-fifth percentile.

2—fiftieth to seventy-fifth percentile.

3—twenty-fifth to fiftieth percentile.

4—worse than twenty-fifth percentile.

The superscript (Italic face) numbers indicate the number of frequencies with thresholds worse than "skew" criteria. See text for details.

thresholds for AP and for CM have been classified in the same way and also appear in Table I. The superscripts to the quartile ratings indicate the number of test frequencies which gave thresholds below our secondary, or "skew" criteria. The 3 μv thresholds for AP were uniformly poor compared with those for the normal ears. The CM thresholds for nine of the 16 ears averaged below the twenty-fifth percentile and for only five ears the thresholds were better than our "skew" criteria at every test frequency.

Three ears from two adult, but not senile, guinea pigs were grossly free of middle ear infection and were tested in the same way. These 3 μv thresholds were classified in Table II.

TABLE II.

Distribution of Thresholds of Three Adult Guinea Pig Ears.
(See Legend for Table I.)

Ear	AP	CM	SP	AP-CM
946R	2	1	1	3
946L	1	1	1	2
921R	3	4^{s}	4	1

Two ears from one animal responded entirely normally. The third ear, from the second animal, showed elevated thresholds for AP, CM and SP. In contrast with the ears of the senile guinea pigs, the difference between AP and CM thresholds was normal.

The distinct elevation of the 3 μv thresholds for CM in the senile ears led us to re-examine the temporal bone specimens for evidence of middle ear pathology which might contribute to a conductive loss of sensitivity. Unfortunately the ossicles were sometimes lost in the process of embedding the specimens; however, in several specimens the ossicles were intact and were found to have shared in the diffuse osteitis noted by Covell and Rogers in the modiolus and outer bony wall of the cochlea. The most severe example is shown in Fig. 1. Although the footplate of the stapes appears normal, the crura have undergone tremendous enlargement, and there appear to be fibrous adhesions between the crura and the niche of the oval window. The same osteitic changes can be

seen in the tip of the long process of the incus near the articulation with the stapes.

One of the grossly normal adult ears (921R) also showed microscopic pathology. There were old fibrous lesions involving the middle ear mucosa in the region of the oval and round windows. The organ of Corti and the spiral ganglion were entirely normal.

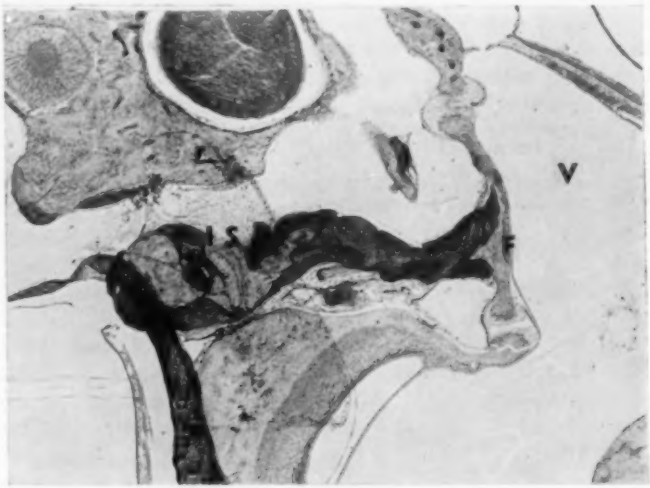

Fig. 1. Photomicrograph of a section through the middle ear and vestibule of a 238 weeks-old guinea pig. The footplate of the stapes shows no changes, but there is only one crus, which is deformed and shows considerable new bone formation. Hyperostosis is present in the lenticular process of the incus although the incudo-stapedial joint is relatively uninvolved. Fibrous adhesions are present between these ossicles and the walls of the middle ear cavity. I-S, incudo-stapedial joint; F, footplate of stapes; V, vestibule.

DISCUSSION.

The cochlear microphone (CM) potential is generated in the hair cells of the organ of Corti and at low and moderate intensities is proportional to the sound pressure. At any given location along the basilar membrane the CM normally provides a relative measure of the acoustic energy reaching the basilar membrane at this location. Elevated 3 μv thresh-

olds for CM imply either that the acoustic energy is not reaching the basilar membrane and the organ of Corti normally or that the hair cells are not capable of responding normally.

Covell and Rogers noted relatively minor changes in the hair cells of the organ of Corti in the first turn of the cochlea. The observed loss of CM was more than we would normally attribute to comparable changes produced by acoustic trauma. Consequently we are inclined to the view that significant conductive losses, probably associated with non-specific osteitis involving the ossicular chain, were also present in many of these ears. The loss of the ossicles from a few key specimens prevents a more definite conclusion; however, it should be noted that such osteitis has not been described in man.

The nerve action potentials (AP) as recorded by this method represent the sum of the approximately synchronized all-or-none impulses from many nerve fibers. In the presence of elevated 3 μv thresholds for CM we expect similar elevations for the 3 μv thresholds for AP even when the neurons of the spiral ganglion are entirely normal. There should be a normal relation between the two thresholds. In Tables I and II the column "AP-CM" describes the relations actually observed. All but three of the senile ears gave difference values that fell below the twenty-fifth percentile of the normal range for this relation and many individual test frequencies gave values below our "skew" criteria. Thus, even when the deficit in CM production was overcome by increasing the sound pressure of the stimuli, AP did not appear. Still further increases in the stimuli were necessary to elicit the 3 μv AP response. This relation is entirely consistent with the loss of neurons in the spiral ganglion for the basal turn reported by Covell and Rogers for these animals.

The ear (921R) of an adult, but not senile, guinea pig which was found to have microscopic middle ear pathology gave bio-electric responses which we believe to be entirely consistent with a pure conductive lesion. More sound pressure was required to elicit the 3 μv CM response, but once elicited the CM could initiate AP responses normally. The threshold differences, "AP-CM", were above the seventy-fifth percentiles of the control values at all frequencies.

The 3 μv thresholds for the summating potential (SP) were also uniformly elevated. SP is probably produced by or depends upon the internal hair cells, and it is perhaps significant that SP thresholds closely parallel CM thresholds in this series of experiments.

These experiments have confirmed the presence of a presbycusis-like process in the guinea pig. In the frequency range used, control of the sound pressure levels of the acoustic stimuli is difficult and distinctly limits the precision of the method. Fourth turn and apical pathology was not anticipated when these experiments were planned. A single electrode on the round window membrane involves the least possible surgical interference with the normal condition of the ear and so minimizes the possibilities for artifacts in the responses to the stimuli; however, this method of recording effectively limits the study to those bio-electric potentials generated in the lower half of the first turn of the cochlea. The potentials so measured do not reflect pathology in other turns of the cochlea. Low frequency tone bursts used with differential recording electrodes in other turns of the cochlea should reveal abnormal potentials associated with the pathology in these other turns. These more difficult electrode placements are likely to produce mechanical artifacts that will decrease sensitivity of the ear to the very high frequencies used in the present study. Psycho-physical studies of presbycusis in humans suggest that the 3 μv thresholds for lower frequencies in other turns may not be very different from normal; however, measurements of the dynamic ranges of the potentials, of the phase relations and latencies of the potentials, and of the time constants of the potentials may reveal significant abnormalities. Such experiments could materially improve our understanding of the pathologic physiology of presbycusis.

SUMMARY.

The bio-electric potentials produced in the ears of senile guinea pigs in response to stimulation by high frequency tone bursts showed elevation of the threshold for 3 μv responses. Neural degeneration in the spiral ganglion, moderate

changes in the hair cells of the organ of Corti and osteitis of the ossicular conducting mechanism were observed in the histologic preparations of the temporal bones. The bio-electric findings reflect the anatomical changes underlying both conductive and perceptive defects of hearing. Together the two sets of observations confirm our present interpretations of the anatomical sources and correlates of these bio-electric potentials. A presbycusis-like process does occur in the guinea pig and makes this animal suitable for more elaborate studies of the pathologic physiology of presbycusis.

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BRANCHIAL CLEFT CYSTS, FISTULAE AND APPENDAGES.*

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INTRODUCTION.

This paper is being presented in an attempt to clarify several controversial points on a subject which has long been clouded by doubts, or by personal conviction, on the part of numerous previous authors.

Fischer[55] says that Hunczovsky, as early as 1789, published two observations on congenital fistula of the neck which had been healed. He says that prior to the publication of his article, Dzondi had been given the credit for first bringing these anomalies to medical attention.

According to Shedden,[156] Ascherson, in 1832, differentiated the lateral cervical from the midline apparatus of the fetus. In 1835 Rathke described branchial clefts in mammalian embryos. Lateral cervical fistulae were placed on embryologic basis as being of branchial origin in 1859. These cysts and fistulae were attributed to thymic origin by Wenglowski[176] in 1912.

Hofer[82] gives credit to Ascherson as first describing branchial cleft lesions in 1832.

Neal and Pemberton[133] say that in 1832 Ascherson thought he recognized a close relation of the branchial apparatus to the cysts and sinuses, which appear on the lateral surface of the neck anterior to the sternomastoid muscle. In 1864, Heusinger[74] introduced the term "branchial fistula."

Volkman[170] reported the first three cases of malignant degeneration of a branchial cleft remnant in 1882. These were seen over a period of ten years, and were not secondary

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to a primary focus elsewhere, or to lymph nodes. All cases occurred in men between 40 and 50.

The statistics herein contained were gathered from Emanuel Hospital, Portland, Ore., and cover a ten-year period—1946 to 1956. My own cases were separately listed. During the years 1946 and 1947 there were four branchial cysts and three thyroglossal cysts operated upon. No fistulae were operated. During the past eight years, 1948 to 1956, a total of 930 neck operations have been performed at Emanuel Hospital. This total figure excludes branchial and thyroglossal anomalies, indicating an incidence of .0527 of these embryological lesions. The neck operations were as follows: Operations on the thyroid gland, including thyroidectomy, 802; parathyroidectomy, 1; radical neck dissections, 32; tracheotomies, 63; tracheostomies, 4; laryngotomies, 7; laryngectomies, 21.

Our incidence of thyroglossal anomalies, compared with operation on the thyroid gland itself was .03, whereas Marshall[114] reports an incidence of .0136 at the Lahey Clinic. This discrepancy might be attributed to a smaller total number of cases, but it certainly seemed worth noting. During this eight year period, 49 cases of congenital cyst, fistula or appendage of the neck have been operated upon at Emanuel Hospital. Twenty-four of these were of thyroglossal tract origin and 25 were of branchial origin. Three of the thyroglossal anomalies were cysts with sinuses; one was a thyroglossal cyst with the development of squamous cell carcinoma, Grade I, in its lining. The remaining 20 were thyroglossal cysts. The branchial anomalies were divided as follows: Cysts, 16; fistulae, 5; branchial remnants or appendages, 4.

Due to a change in the system of indexing diagnoses in the Medical Record room, there has been some difficulty in obtaining complete statistics for the years previous to 1948, and a few additional cases of branchial or thyroglossal anomalies may have been "lost"; however, each case presented here has been confirmed pathologically.

Among the patients who had branchial cleft cysts, the ages varied from four and one-half years to 65 years. The

duration of onset varied from birth to 65 years. The interval between onset of symptoms and the time of surgical intervention varied from one month to six years. The condition was found to be equally proportioned as to sex incidence, showing no preference for male or female. The size of the cysts varied from 5.5x4.5x2.5 cm., which was the largest, to 2.5x1.6 cm., which was the smallest. The majority of the patients were asymptomatic aside from the presence of a tumor mass in the side of the neck. Four patients complained of some localized pain. One noted pain radiating to the right ear and soreness below the right jaw. Three patients complained of pressure, especially on turning the head to the side opposite the cyst. Two patients described dysphagia, and one had some difficulty with speech. One patient was told that she had nothing wrong with her other than a "middle age spread" of the neck when she consulted another physician prior to her surgery.

The difficulty in establishing a correct preoperative diagnosis is well demonstrated by the frequency of error. Four of these cases were diagnosed incorrectly: parotid tumor, submaxillary gland, tumor, right submandibular region and thyroglossal duct cyst. The patient who was thought to have a thyroglossal cyst was found to have the cyst attached to the hyoid bone at the time of surgery. In addition, five other patients are not included in this series for the obvious reason that the pre-operative diagnosis was not confirmed in the pathology laboratory. Among these were: an epidermoid inclusion cyst; submaxillary salivary gland; sublingual gland; granulomatous inflammation, foreign body type, to keratohyalin in subcutaneous tissue of neck, and a deep-seated, cavernous hemangioma. One of the cases of branchial cleft cyst showed focal chronic granulomatous inflammatory reaction, not definitely characteristic of tuberculosis involving the wall of the cyst. Four years later, the same patient was re-admitted to the hospital and the diagnosis of tuberculosis of the clavicle with abscess and draining fistula of the left infraclavicular fossa due to tuberculosis was made.

The patients having branchial fistulae varied from two to 21 years. In all instances, the fistulae had been present since

birth. Two were female and one was male. The presence of a draining fistula was the only symptom in two of the cases. The other case showed multiple fistulae in a small area, approximately 1 cm. in diameter, with a small underlying cystic mass. This patient had a history of recurrent attacks of acute infection with drainage following the infection. There was no instance in which a hereditary factor could be shown. All cases were unilateral. The right side was involved in two cases, and the left side was involved in one.

BRANCHIAL CLEFT CYSTS.

Embryology.

Wenglowski,[176] in 1912 published the results of an exhaustive five-year study of the subject involving 246 cadavers and 75 embryos. His observations indicated that the branchial apparatus can not have remnants *below the hyoid bone.*

Bevan[16] feels that branchial cysts are due to embryonal arrests left from the branchial clefts in the tissues of the neck. In his experience they begin to grow and develop cystic tumors from the tenth to the 30th year.

Hyndman and Light[88] disagree with Wenglowski as to embryogenosis. They conclude: *1.* Branchial cleft anomalies (cysts and fistulae) result from a failure of absorption of the included ectodermal and entodermal epithelium that is buried during the growth and fusion of the branchial arches in early embryonic life. This is probably the sole explanation, the thymic stalk playing no role. They classify branchial cysts as follows: *1.* Branchial cleft epidermoid cysts; *2.* branchial cleft mucous cysts.

Ladd and Gross[101] disagree with Wenglowski. They state that the constancy of the location of the cervical fistulae in relation to what would be the course of the upper branchial clefts leads them to believe that these congenital defects actually represent a persistence of one of these structures.

C. Rabl,[142] (cited by Malcolm and Benson[113]) theorized that the cervical sinus alone was responsible for branchial cysts.

He stated: "If both internal and external openings of the second cleft close normally and the precervical sinus has not been obliterated completely, a branchial cyst will result which, because of its epithelial structure, may give rise to a branchial dermoid or carcinoma." It is cases of this type, referable to enlargement of the cervical sinus, that Malcom and Benson designate as cysts of the cervical sinus; however, in their experience they constitute no more than 4 or 5 per cent of all branchial cysts. They say that Bailey's Type II is due to enlargement of the sinus *per se*. Frazer[57] has elucidated this. They believe that Rabl, Frazer and Bailey combined have the answer to origin, and Wenglowski is in error.

Bailey's Type I of branchial cyst is referable to the elongated tract leading into the sinus. Type II is due to enlargement of the sinus itself. Type III points to enlargement of the second external duct with more or less enlargement of the sinus also. Type IV is of no clinical interest, but is possibly due to enlargement of the internal duct.

Thompson[164] reviews the embryology of the branchial apparatus with special attention being directed to the migration of muscles and showing how the migration can be traced by their blood and nerve supply. He believes that most lateral cervical cysts, including ranulas and submaxillary cysts, develop primarily from the *cervical sinus*, and that their varying position is attributable to the above mentioned shifting of muscles during the formation of the neck. Payne[139] agrees.

Frazer,[57] from his study of the lateral neck of embryos, concluded that the cervical sinus does not close so early and so completely as is usually thought, and might well be an important factor in the formation of anomalies. He says that every vestigial remnant in the neck, that has a deep connection as well as an outer opening, would have to pass upward to cross the hypoglossal nerve before it could run to its original deep attachment. He thinks that the term "branchial cleft cyst" should be dropped and "lateral vestigial cyst" should be substituted, modifying this with ectodermal

or entodermal as the case might prove by microscopic examination.

Hicks[77] states that Wenglowski reconstructed models from more than 60 human embryos and concluded that branchial cysts took their origin in the course of the thymus as it grew down in the neck as a tube from the third pharyngeal pouch; however, the absence of unequivocal thymus tissue in most branchial cysts, and the course of few cysts that run from the tonsillar region to the lower neck are the most convincing reasons for *not* accepting Wenglowski's theory without reservations. Further, in 100 cases of branchial cysts reviewed for histologic characteristics in his laboratory, no unequivocal thymus tissue was seen, but one cyst did have a small parathyroid gland in its wall.

Hunt[67] disagrees with Wenglowski's theory. He believes that Hicks properly describes the embryology of branchial cysts and fistulas.

King[94] refutes the branchial, precervical sinus and thymic duct hypotheses "partly because embryological investigations have indicated their inadequacy, and because the cysts do not show any constant features which might support these speculations." He says that the relationship of the cysts to lymph nodes and lymphoid tissue suggests an alternative hypothesis.

Malcom and Benson[113] say that Rabl,[142] in 1887, described the formation of the branchial clefts and cervical sinus and demonstrated how they were obliterated by apposition of ectoderm with entoderm followed by disintegration of cells. He showed that the second cleft was much more apt to persist embryonically because of its greater depth and normally much longer persistence. He concluded that the second cleft and its attachments were almost inevitably at fault in the formation of branchial anomalies. Malcom and Benson agree.

Ward, et al.[173] think that all the various theories have an element of fact in them. They say that all that can be said with certainty is that these anomalies have some relation to the branchial apparatus and that they can be grouped together under the heading "branchiogenic abnormalities."

Proctor[141] gives an excellent and definitive review of the embryology of branchial cysts and fistulae. He says that failure of obliteration of the cervical sinus or the embryonic thymic duct may give rise to occasional persistent anomalies; however, these are rare.

Heredity.

In all of the literature reviewed, only Sedgwick and Walsh[152] show evidence which indicates the involvement of hereditary factors in the case of branchial cleft cysts. They found only two cases of 59 which had branchial cysts in which there was a similar history in the immediate family.

Conway and Jerome[37] present 90 cases of branchial cleft cyst and fistula. They believe, based on their report, that hereditary influence should be completely disregarded as a predisposing factor in the case of branchial anomalies.

Symptoms.

Hanlon and Seybold[70] report a case of rapidly developing branchial cyst which caused marked respiratory obstruction at the age of five days. Symptoms were completely relieved by removal of the cystic tumor mass.

Others[13,133] quote similar symptoms.

H. Bailey[4] says that swelling of a branchial cyst occasionally varies in size. Occasionally dysphagia or pain may be related as a symptom.

Beck[13] says that branchial cleft cysts may produce stridulous breathing, severe cyanosis, and dyspnea in repeated attacks in children.

Douglas[49] reported a case of a man, who, by holding his mouth and nostrils shut, and blowing hard, could distend the right side of his neck with air, which, when pressed on afterward, could be emptied into the pharynx with a gurgling sound. This evidently was due to an opening of the inner end of the branchiogenetic sinus into the pharynx.

Sedgwick and Walsh[152] describe a similar case.

Thompson[164] describes a case in which there were recurrent

bouts of aphonia, dysphagia and dyspnea. These attacks were relieved by spontaneous rupture of the cyst. Due to increasing frequency of attacks, the patient submitted to operation which completely relieved the symptoms. After surgery the previously fixed left vocal cord also regained function.

Watson[175] reports a case of infected branchial cyst which encroached on the glottis, causing suffocation and death. This cyst pierced the larynx at the level of the right ventricle and proceeded in a downward and inward direction with its bulbous extremity on the vocal cords. It never caused hoarseness or aphonia and had caused no symptoms until some six months before death. These symptoms were presumed to be due to an infection of undetermined etiology, but were mistakenly diagnosed as asthma.

Rosenberger[146] reports a congenital cyst of the right laryngeal ventricle occurring in conjunction with a lobus azygos of the lung, terminating fatally at the age of six weeks, due to obstruction to respiration and bronchopneumonia.

Hyndman and Light[88] quote Coplin[38] as saying that the cyst often becomes larger and more tense during the process of salivation, when stimulated by citric acid or mastication, even when it does not communicate with the alimentary canal.

Ward et al.[173] had a patient whose branchial cyst emptied its contents into the mouth on pressure, producing a very foul, nauseating odor. Another noted gurgling sounds when fluids were swallowed.

Ladd and Gross[101] operated upon only 47 of their 82 cases, because they felt that the symptoms were too insignificant in the others.

Coakley[34] relates a very interesting case of branchial cleft cyst which simulated a chronic retropharyngeal abscess.

Ochsner[135] reports a case of branchial cleft cyst which had symptoms of pain and induration of the left sub-parotid area at frequent intervals, usually preceded by upper respiratory infection. Nearly one year later, after several consultations, and a tentative diagnosis of mumps or salivary calculi, the cyst was finally removed surgically.

Hoogland[83] describes a nasopharyngeal cyst of branchiogenic origin. This cyst apparently produced a serous otitis media, because puncture of the cyst relieved the symptoms.

Baumgartner[10] describes a purulent thyroiditis occurring in a nodular thyroid following incision and drainage of an infected branchial cyst after a few days. He also reports a brachial plexus neuritis following removal of an infected cyst.

Differential Diagnosis.

H. Bailey[6] states that branchial cleft cysts are frequently confused with tuberculous adenitis, in that the aspirated fluid from both is quite similar in appearance. He states that the differential diagnosis of a cyst or tumor of the neck may be difficult. The following conditions must be considered: *1.* Breaking down tuberculous glands—other glands will be affected. These glands should be palpated systematically; *2.* cystic hygroma is translucent and lies in the lower half of the neck and may be loculated; *3.* solitary lymph cyst which usually lies in the supraclavicular triangle of the neck is translucent and usually occurs in adult life; *4.* deep-seated venous hemangioma—"sign of emptying" may be employed. Pressure causes the tumor to empty slowly and then slowly refill when the pressure is released; however, the retropharyngeal space must be watched at the same time, because deep ramifications of the cyst may cause it to empty into the retropharyngeal space; *5.* chronic retropharyngeal abscess occasionally has deep ramifications, causing swelling in the retropharyngeal region; *6.* lipoma is usually superficial to the fascia. A subfascial lipoma can rarely be aspirated, whereas a branchial cleft cyst usually can; *7.* cystic degeneration of a malignant neoplasm—it is unusual for a branchial cyst to make its first appearance at a "carcinomatous age;" *8.* thyroglossal cyst is not necessarily in the midline, but bears no relation to the sternomastoid muscle and *never* lies deep to it; *9.* myxomatous degeneration of a mixed tumor of the parotid is a rarely seen pathological curiosity; *10.* aneurysm shows pulsation, whereas a branchial cyst does not.

He notes that in 11 cases a mistaken diagnosis of breaking

down tuberculous glands had been made, whereas, in reality, the diagnosis was branchial cyst. He stresses the presence of cholesterol crystals as being diagnostic. He says he had one case in which tubercle bacilli were present. The cyst, *1.* appears in early adult life; *2.* in the upper third of neck; *3.* is lined with stratified squamous epithelium; *4.* is filled with opaque fluid rich in cholesterol.

Johnson[93] says that thyroid cysts may closely simulate branchial cysts. They can, however, usually be traced to their attachment to the gland, and they move with it.

Klingenstein and Colp[97] say that they excised a cystic swelling on the right side of the neck at the level of the thyroid cartilage. Its position was so far lateral to the median line that a diagnosis of thyroglossal cyst was barely entertained. In spite of this fact, a prolongation of the cystic mass was found to run to the under surface of the hyoid bone, exactly in the median line, and the pathological report of the excised cyst wall and tract was "thyroglossal cyst". They stress the fact that although the opening of the cyst or fistula might be eccentrically placed, the tract itself is almost invariably found in the median position.

Colp[35] reported two cases of dermoid cyst of the floor of the mouth and included the records of 32 other cases.

Imperatori[89] reported a case of multilocular branchiogenetic cyst which intruded itself into the ventricle of the larynx. It was removed by thyrotomy.

Rosenberger[146] reports a somewhat similar case.

H. W. Meyer[128] thinks that dermoid, cystic hygroma, lymphangioma (endothelioma and endoblastoma), cyst of the thyroid, parotid tumor, Hodgkin's disease, angioma, lipoma, carotid tumor and chronic retropharyngeal abscess must be considered in a differential diagnosis of branchial cleft cyst.

Patterson[138] had one case in which the cyst was visible as a marked swelling of the larynx and had caused partial displacement of this organ. It had been punctured twice. The cyst was adherent to the thyrohyoid membrane and to the

pharynx, and much difficulty was experienced in its removal while attempting to avoid perforation into the pharynx.

Ward et al.[173] had two patients that had previously, incorrectly, been treated with X-ray. They had been diagnosed as Hodgkin's disease and tubercular adenitis (both without biopsy).

McNealy[124] mentions aneurysms for consideration in a differential diagnosis; he says that branchial cleft cyst has no bruit and is not expansile. Aspiration with a fine needle settles the diagnosis.

McLaughlin[123] says that occasionally branchiogenic cysts may develop with surprising rapidity, thereby adding to the confusion in a differential diagnosis.

Hitz[81] reported a case of sublingual epithelial cyst (different from dermoid, as explained by Colp[35] in 1925, and agreed upon by Meyer[127] in 1932), which must be included in the differential diagnosis of branchial cleft cysts.

Lahey[102] believes that the following pathologic entities should be considered in the differential diagnosis of any tumor of the neck: *1.* Inflammatory salivary gland swelling with calculus; *2.* mixed tumor of the submaxillary gland; *3.* carotid body tumors; *4.* branchial cysts; *5.* neurofibromas; *6.* discrete parathyroid cancer; *7.* discrete aberrant thyroids; *8.* discrete Hodgkin's disease; *9.* discrete lymphosarcoma; *10.* discrete branchiogenic carcinoma; *11.* discrete tuberculous cervical nodes; *12.* discrete adenoma of the thyroid; *13.* lipomas; *14.* lateral dermoid cysts; *15.* hygroma (cystic).

Konig[99] had a case in which the internal opening of a branchial cyst was in the glottis. There was a question as to whether this might be due to secondary infection and perforation, or whether it was due to a persistent anlage duct of the lateral lobe of the thyroid which would enter internally at the entrance into the glottis.

Cunningham[45] reports a case of branchial cyst of the parotid gland.

Harris[71] presents a case of branchiogenetic cyst of the nasopharynx occurring in a 30-year-old woman who had no symptoms prior to six months before examination.

Gill[63] reports seven cases of cyst of the neck and two cases of parotid gland tumor. He, too, stresses the presence of cholesterol in branchial cleft cysts as being diagnostic.

Schwartz[150] presents a case of branchiogenetic cyst, which he thinks at one time communicated with the tonsil fossa, and due to cicatrization that took place following a series of peritonsillar abscesses, the opening was obstructed, giving rise to the subsequent mass formation in the neck.

Sedgwick[151] says that thyroid adenomas are easily distinguished from branchial cysts, as the adenomas move when the patient swallows. Carotid body tumors pulsate and are usually more deeply seated, and cannot be so easily displaced as branchial cysts.

Gaston and Albros[62] report a case in which both a thyroglossal and branchial cyst were detected and operated upon in the same patient.

Byars and Anderson[24] report three cases of anomalies of the first branchial cleft. They say that such an anomaly should lie high in the neck, above the hyoid, but below the lower border of the mandible, and probably opening into or in close proximity of the external auditory canal.

Hevenor and Clark[75] present 20 cases of adenolymphoma (papillary cystadenoma lymphomatosum), all of which responded well to surgical extirpation without the addition of prophylactic irradiation. They hold that these tumors could easily be confused with branchial cleft cysts or branchiogenic carcinoma.

Williams[179] reports an interesting case in which a six-year-old boy had what appeared to be a submaxillary calculus on X-ray examination, and after removal of the submaxillary gland, a branchial cleft cyst was found lying deep to the gland, and attached firmly to the hypoglossal nerve.

Taylor and Burwell[162] report four cases of nasopharyngeal

cysts, two of which were bilateral. The attachments of these cysts lay along the lateral border of the nasopharynx.

Montreuil[131] believes that congenital cysts and fistulae of the neck properly belong in the field of the otolaryngologist, for he, alone, is capable of properly examining the different cavities of the head and neck whereby a possible focus or primary tumor might be located when dealing with lumps of the neck.

Cervical adenitis, unilateral, of undetermined etiology, may be somewhat confusing as to differential diagnosis with branchial cleft cysts. This condition has not been mentioned by any other authors as an additional problem in the process of differential diagnosis; however, tenderness, malaise, fever, and systemic evidence of illness are helpful in clarification of the actual condition present. The cervical adenitis responds slowly to large doses of antibiotics over a seven to ten day period.

Incidence.

Day and Gent[48] report 13 branchial cleft anomalies from 1946 to 1952. They felt that three of these were anomalies of the first branchial cleft, whereas other authors, one of 90,[88] one of 82,[101] none of 319,[133] three of 160[143] and one of 174[66] found a much lower proportion.

Andreassen[1] operated upon 18 cases of congenital cyst or fistula of the neck. Twelve of these were thyroglossal in origin, and six were branchial.

Lyall and Stahl[111] present 67 cases of lateral cervical cysts, sinuses and fistulae gathered over a 20-year period at the New York University Post Graduate Medical School.

Sedgwick[151] says branchial cysts occur equally in both sexes, and that most cysts are first detected between the ages of 20 and 30 years.

Ladd and Gross[101] report two cases of bilateral cervical cysts.

Ward, Hendrick and Chambers[173] found branchial cysts occurred with wide age variation—two months to 81 years.

They found nearly twice as many cases occurring in males as females (45 to 25). White and colored are equally affected. Symptoms had been present from six weeks to 24 years.

Hyndman and Light[88] found that branchial cysts ordinarily first occur at age 17 (those that are not present at birth), and were of four years' duration at the time of first examination. The right side was involved in 35.5 per cent and the left side in 64.5 per cent of cases.

Neel and Pemberton[133] found three patients who had had symptoms of branchial cleft cyst for over 40 years. They reported 319 cases of lateral cervical cysts or fistulae. All were operated, and the pathological specimen was examined by a surgical pathologist in each case.

Brown, J. M.,[22] stated that in the last ten years at St. Vincent's Hospital in Los Angeles, 20 cases of congenital lesions of the neck were recorded. Thirteen originated from branchial apparatus and seven from the thyroglossal duct. These were equal as to sex incidence. The ages varied from three and one-half years to 63 years. Ten of the branchial lesions were without fistulae; two had internal openings; one had an external opening; three had had previous surgery.

H. Bailey[4] found branchial cleft cysts occurred equally in regard to sex. Sixty-five per cent of cases occurred between ages 17 and 30. Symptoms had been present for 12 to 18 months. One patient had had symptoms for ten years.

Hanlon and Seybold[70] say that the majority of branchial cysts are *unilateral* and rarely connect with the pharynx.

Shedden[156] presents 51 cases; of these, one-third occurred in the second decade of life. If the cases occurring in the third decade are added, the totals are two-thirds of the cases studied. He had 42 cysts and nine fistulae in 51 cases, and only one fistula was bilateral. He had no bilateral cysts.

Marshall[114] says that thyroglossal cysts are the most frequently occurring primary tumor of the neck, excluding those of lymphatic origin (and thyroid gland). In the Lahey Clinic up to January 1, 1951, three hundred and eighty-eight patients had been operated upon for either thyroglossal cyst

or fistula, and 29,421 operations had been performed for thyroid disease other than thyroglossal lesions; therefore, the relation of disease of the thyroglossal tract to thyroid disease was 1 to 76. Unfortunately, he gave no comparison of incidence between thyroglossal and branchial cysts and/or fistulae.

Diagnosis.

H. Bailey[6] describes four types of branchial cleft cyst:

1. Does not extend deeply, but lies on the anterior border of the sterno-mastoid muscle, beneath the cervical fascia.

2. Passes down and lies on the greater vessels. The wall has to be carefully separated from the internal jugular vein to which it is varyingly adherent. This appears to be the commonest type.

3. Extends inward toward the lateral wall of the pharynx. It passes between the external and internal carotid. A prolongation may pass upward as far as the lateral mass of the atlas, and even up to the base of the skull.

4. Columnar-lined cyst lying just lateral to the pharyngeal wall and deep to the great vessels. These rarely give rise to symptoms.

Bailey emphasizes the frequency of the following complications:

1. Occasionally the non-aspirated cyst is the seat of recurrent attacks of subacute inflammation. Exceptionally, suppuration occurs.

2. Accidental or intentional incision of the cyst is likely to result in (acquired) fistula.

Physical signs of branchial cleft cysts are as follows: *1.* The swelling is cystic; *2.* the position is constant. It lies in relationship with the deep surface of the upper one-half of the sterno-mastoid muscle and nearly always protrudes around the posterior border. Commonly its center is around the great cornu of the hyoid bone.

Johnson[93] also thinks that the cysts remain constant in

position. They are usually located between the angle of the jaw and the sterno-clavicular junction externally at the anterior border of the sterno-mastoid.

Beck[13] says that a branchial cyst is occasionally seen in the posterior triangle of the neck, but then other conditions should be considered first. He says that infection is the most common complication. During the infection, the skin overlying the cyst becomes discolored.

Langenbeck[103] reports two cases of branchial cleft cyst which were firmly adherent to the jugular vein, following repeated infections and attempts at conservative treatment.

Schede[148] reports three of Volkman's cases in which, although lying on the cervical vessels, the cystic tumors were in no case adherent to them.

Senn[155] reports three cases of his own. In one, the cyst was adherent to the jugular vein (which was lacerated and then ligated with catgut). One case refused operation, and the other may have been a dermoid cyst of the floor of the mouth.

Hicken and Popma[76] and Hunt[87] use thorium dioxide solution after aspirating the cyst prior to X-ray for diagnosis.

Wangensteen[171] advises aspiration of branchial cysts through a hypodermic needle. He then injects a radio-opaque medium and takes X-rays leaving the needle *in situ*. After the film is taken, he then re-aspirates the radio-opaque medium.

Seed[153] reports a case of a true dermoid cyst of the neck which broke through the skin and drained intermittently, causing it to be mistaken for a branchial fistula. It was removed following the injection of molten paraffin colored with methylene blue.

Crow[43] reports a case of internally draining branchial cleft cyst, which was surgically removed.

Sedgwick and Walsh[152] found 35 branchial cysts anterior to the sterno-mastoid muscle in its upper one-third; four were anterior to the muscle in its middle third, and three

were anterior to the muscle in its lower third; three were posterior to the muscle in its upper third, one was posterior in the lower third, and two lay along the entire extent of the muscle; five were found lateral to the muscle and one lay in the suprasternal notch. They also had three which lay anterior to the muscle with the exact location unknown, and two others in which the exact location was not definitely recorded.

Haley and Jackson[68] describe a hemangio-endothelioma of the salvary gland which was successfully operated in a four-month-old child.

Numerous authors[156,93,65,12,100,85,172,76,87,,112,171,153,180,30,130] stress the injection of various materials as a means of diagnosis.

Others[5,179,63,76,87] believe the presence of cholesterol crystals to be of great diagnostic importance.

King[94] suggests the use of the term "lateral lympho-epithelial cyst" to replace branchial cyst.

Russell[147] prefers the term branchial to lateral cysts and fistulae.

Carp and Stout[26] say that branchial cysts have been referred to under varying names, including "sequestration dermoids" (by Cunning).

Pathology.

Gross[66] says that in order to be classified as a vestige of the first branchial cleft, a lateral cervical cyst, fistula or sinus must connect with the external auditory canal, either by a blind pouch in the cartilage of the canal or a draining sinus into the external canal or connect with the Eustachian tube.

Taylor and Burwell[162] report four cases of nasopharyngeal cysts, two of which were bilateral. The attachments of these cysts lie along the lateral border of the nasopharynx, with the upper extent of attachment being in the region of the Eustachian tube orifice. The lower extent of attachment was found to be a little above and behind the upper pole of the tonsil. One of the unilateral cysts was thought by the authors to be a retention cyst of a sero-mucous gland. The

other cysts described were said to be derived from the second branchial pouch.

Bill and Vadheim[16] report 18 congenital lesions of branchial origin treated surgically. They feel that 13 of these are of second branchial cleft origin, while five are of first branchial cleft origin. They think, based on their experience, that branchial anomalies derived from the first cleft are, perhaps, more common than previously realized.

Conway and Jerome[37] found in their cases that the cysts occupied one of the four following positions: *1.* Superficially located, directly beneath the skin; *2.* it may be of greater size and extend to the great vessels of the neck; *3.* it may extend inwardly to straddle the internal and external carotid arteries and come in contact with the pharynx—this type may extend superiorly as high as the base of the brain; *4.* the cyst may be a small vestigial structure situated deeply and adherent to the wall of the pharynx. They stated that the average cyst was about 3 or 4 cm. in diameter; however, the largest of their series measured 15x12x7 cm.

Lyall and Stahl[111] report four cysts having tracts which led to the external auditory canal; however, none had discharge from the external auditory canal. Other authors have considered concomitant ear discharge as being diagnostic of anomalies of the first branchial cleft; however, Lyall and Stahl do not concur.

Hanlon and Seybold[70] say that the enlargement of branchial cysts is the result of secretion and desquamation of epithelial lining. The presence of infection may produce rapid swelling and signs of acute inflammation. Microscopically there is usually a distinct structure in the form of stratified transitional epithelium overlying accumulations of lymphoid tissue which show germinal centers.

H. Bailey[6] says that the typical lining of the cyst is stratified squamous epithelium; further, it is surrounded by lymphoid tissue.

Baumgartner[10] says that both the cysts and sinuses are

lined with squamous epithelium, surrounded by lymphoid tissue.

Bevan[16] says that branchial cysts are filled with pea-soup material as a rule, but may contain dark fluid, possibly as a result of hemorrhage. Johnson[92] concurs.

J. W. Thompson[164] described a case in which a branchial cyst was found to be attached to the larynx, hyoid bone and lateral wall of the pharynx.

Neel and Pemberton[133] feel that an infected branchial cyst or sinus may act as a focus of infection.

Gaston[61] said that lymphoid follicles are such a constant finding in branchial cysts and fistulae that the presence or absence of such tissue assumes diagnostic importance. Neel and Pemberton[133] and others disagree.

Hyndman and Light[86] quote Virchow and Hirsche as having had a case of an infant in which the whole side of the neck and thorax on that side down to the umbilicus was involved in a branchial cyst.

Cates[28] presented one case of branchial cleft cyst removal followed by a Horner's syndrome.

Belk[14] reports ten cases of branchiogenic tumors of the neck. Most of these were parotid tumors or endotheliomas, however.

Jackson[91] reports 13 cases of branchial cyst, 11 of which were successfully operated upon. Two of the patients refused operation.

Daniels[47] reports a case of tumor of the neck of a child at birth which extended from the ramus of the jaw to the clavicle below. Operation occurred at the age of five weeks. Microscopic examination revealed the tumor to be a teratoma with no evidence of malignancy.

McFarland[121] says that a branchial cyst may be lined with stratified squamous epithelium if its arises from the vestigial remains of an external branchial furrow or pre-cervical sinus. If it arises from an internal branchial furrow, it may be

lined with columnar epithelium that may be ciliated. In some cases, linings of both types occur in different parts of the same fistula or cyst.

Hoogland[83] reports a case of nasopharyngeal cyst of branchiogenic origin. He says that these may be differentiated from cysts of adenoid origin by entodermal rather than ectodermal origin (he has no microscopic report to prove this).

Sedgwick and Walsh[152] report that of 12 specimens studied microscopically, seven showed the sinus tract to be lined with stratified columnar epithelium, and three cases showed *no* evidence of epithelium. Two cases showed the tract to be lined with pseudostratified columnar epithelium. Only three specimens revealed lymphoid tissue. Other significant microscopic findings were fibrosis and chronic inflammation. They also found that 14 of 59 branchial cysts were attached to the pharynx.

Ward et al.[173] state that cysts and sinuses may have stratified columnar or squamous epithelium, or both types may be present in the same cyst. The columnar epithelium may possess cilia. Well-formed lymph structures, including germinal centers, are noted in the cyst wall. They feel that squamous epithelium may be found deep in the lymphoid tissue, and may even show keratinization. They say that this condition is *precancerous*. Muscle fibers may also be seen in the cyst wall.

Treatment.

Andreassen[1] feels that the only reason for treatment of branchial anomalies is the production of unpleasant symptoms, because he thinks that the risk of malignant degeneration hardly exists.

Hunt[87] thinks that these lesions require complete surgical excision.

Taylor and Burwell[162] reported four cases of nasopharyngeal cysts, two of which were treated by aspiration of the liquid content, followed by injection of one ml. of a five per cent aqueous solution of Ethanolamine Oleate. A second injection of the sclerosing agent was required six months later in one

of the cases. Transpalatal excision was planned for one of the cases. No form of treatment was described as having been done or contemplated on one of the unilateral cysts. The authors say that aspiration followed by injection of a sclerosing agent is the treatment of choice for cysts of this type; however, if this method fails, they advise a transpalatal approach with complete excision of the mass.

Ward and Hendrick[172] believe that preventive treatment should be instituted, if possible, by removing branchiogenic cysts in their entirety before malignant degeneration begins.

Stahl[161] says that in excision of cystic anomalies of the first branchial cleft the accompanying tract frequently traverses the parotid gland, and may run either superficially or deep to the facial nerve. Careful dissection of the nerve fibers is necessary. In some instances it is necessary to remove a small cuff of the cartilaginous external auditory canal in order to insure complete excision.

Bevan[16] says that several years before, Senn and Fenger, rather than completely extirpating the branchial cleft cysts, removed the bulk and left the portion which was adherent to the internal jugular vein, cauterizing the surface with Paquelin cautery.

Beck[13] recommends conservative treatment for the infection of branchial cysts. He says that unless the size of the cyst is causing respiratory embarrassment, or becoming infected repeatedly, surgical treatment should be postponed until the child is one year to 18 months of age.

Ladd and Gross[101] advise that Michel clips, or preferably, running subcuticular stitch with silkworm gut on a straight Keith needle will do the best job of closing the wound.

They direct attention to the fact that in removal of a cyst, one must always bear in mind the possibility of an associated sinus, for if this were left the cyst would be likely to recur.

Bickham[17] recommends a collar incision and complete removal of cysts, if possible. He says that complete removal

often is not possible due to adhesions, so the remaining membrane should be removed by cauterization or curettage.

Senn[155] discussed the following methods of treatment: *1.* Incision; *2.* actual cautery; *3.* seton; *4.* puncture with subsequent injection; *5.* extirpation; *6.* antiseptic drainage. He thinks extirpation was the treatment of choice except in infants, where he recommended antiseptic drainage.

Jackson[91] uses cervical block anesthesia preceded by sedation for excision of branchial cleft cysts.

Smith[160] believes the use of a fine silk or sewing cotton seton passed superficially through the tumor is the treatment of choice. He says surgery is too risky. He discussed injection and local application of iodine and the results.

Larson[104] stresses complete extirpation. He says that he had 16 2/3 per cent recurrence in 30 branchial cleft cysts and fistulae which he had operated upon.

Gill[63] notes that some parotid gland tumors are difficult to differentiate from branchial cysts. In case a mistaken diagnosis is made, and the actual pathological entity is found to be that of a parotid gland tumor, he warns that if the capsule of the tumor is ruptured in the process of excision, the entire gland must be removed. He also warns against the use of X-ray or radium prior to receiving the pathological report.

Hall[69] withdraws fluid from the cyst and injects lipiodol prior to excision.

McCaskey[119] advises complete excision of both branchial cysts and of fistulae.

Bailey[6] advises, in surgical removal of branchial cleft cysts, that thorough cleaning of the presenting surface of the cyst be done; then it should be punctured, letting out about one-half of the contents. The puncture wound should then be covered with gauze, held in place with a sponge-holding forcep. This, he feels, permits more mobility, as well as a means of retraction in the complete excision of the cyst.

While Bailey's technique of excision of branchial cleft

cysts seems most logical, it has never worked out well in my hands; because the wall of the cyst is ordinarily so thin and friable that, once opened, it is extremely difficult to obtain a satisfactory hold on the wall of the cyst so as to prevent further egress of the fluid contents, without producing gradually a larger and larger rent in the presenting surface, and thus permitting escape of all of the fluid contents.

Etiology.

Conway and Jerome[37] had cases in which trauma might have been considered a predisposing factor in branchial anomalies; however, they believed that the injuries merely called attention to the already existent condition. They thought that the possibility of malignant transformation can be dismissed.

Johnson[93] had one patient, a 24-year-old woman, who had undergone tonsillectomy one and one-half years prior to her examination. She stated that a small lump had appeared at the angle of her jaw one week after surgery. This lump had gradually increased to the diameter of a medium-sized orange.

Others[5,121,100] have had similar experiences.

McFarland[121] states that all mixed tumors of the neck are branchiogenic, but all branchiogenic tumors are not mixed.

BRANCHIAL CLEFT FISTULAE.

Embryology.

Frazer[57] states that the location of the tract is determined embryologically and is always constant. Remnants of the second external cleft pass between the external and internal carotids, in front of the vagus, to reach the pharynx at the tonsillar fossa, and those of the third external cleft pass behind the common carotid and in front of the vagus to the pyriform fossa. He also says that the fourth external duct is drawn down by the arch of the aorta on the left and the subclavian artery on the right, and its medial end is the lower end of the pharynx.

Wenglowski[176] says that the branchial fistulae are persistent remnants of the thymic duct, originating from the third pharyngeal pouch and pursuing a long, oblique course down the neck.

Baumgartner and Steindel[11] and others[100,13,124,127,180,69,97,20,90,104] agree with Wenglowski's theory.

Patten[137] states that cervical fistulae may arise from either the second or third pouch. The external opening appears along the medial border of the sterno-mastoid muscle in either case. He thinks that fistulae from the second pouch begin internally in the tonsillar fossa and usually make their exit in the neck near the level of the pharynx. Those from the third pouch leave the pharynx below the level of the hyoid bone and reach the cutaneous surface near the base of the neck.

Arey[2] says that somewhere between the third and fourth week, the branchial apparatus of the human embryo begins to develop, and then disappears before the end of the second month. He is noncommittal as to the origin of fistulae, saying that opinion is diversified.

Carp[25] explains the relationship between the branchial cleft fistulae and the facial, glossopharyngeal and vagus nerves on the basis of Rabl's theory.

McKenty[122] says, "If the development of the vessels is normal, a fistula of the second cleft must lie between the external and internal carotid arteries; a fistula of the third cleft between the common carotid artery and vagus nerve; a fistula of the fourth cleft bends around the subclavian on the right side and arch of the aorta on the left side."

Several other authors[50,177,122] contend that the formation of complete fistulas from the third or fourth cleft has never been found.

Bailey[5] describes which part of the second cleft is involved. He says that fistulas are similar to cysts in that they may be divided into three types. He disagrees with Wenglowski in that: *1.* A persistent branchial cartilage is illustrated, a remnant, the origin of which can not be disputed,

situated in the lower third of a child's neck in the exact position where a branchial fistula commonly opens; *2.* a cervical auricle, by its structure, clearly a homologue of the pinna, is situated at the point where a branchial fistula usually opens; *3.* histologically a branchial fistula is usually lined by columnar epithelium, and its walls contain some muscle; there are no reasons why a thymic bud should contain these elements; *4.* the anatomical relationships of a branchial fistula as displayed during an operation for its extirpation are in keeping with those depicted in works on embryology as belonging to the cervical sinus and the second cleft which persists in the goat to open into the fossa of Rosenmuller.

N. W. Gill[64] subscribes to the Rabl theory of origin of the fistula due to persistence of the cervical sinus of His.

Williams[179] complains that all of the extensive embryological literature on the subject of branchial fistula has not elucidated to him the superficial nature of the tract in its lower one-third.

Matas[117] reported a case of a blind branchial fistula in which a cervical auricle was also noted.

Kingsbury[95] gave an extensive and excellent description of development of the human pharynx.

Ladd and Gross[101] conclude that the great majority of congenital fistulae of the neck are actually derived from the second branchial cleft and pouch.

Leegaard[105] says that the predominant frequency of lateral fistulae on the right side can, with some likelihood, be explained by normal embryology. In rare cases the outer fistula mouth lies below the clavicle. The situation of the inner fistula mouth seems to be constant, as up to now suggested, insofar as it almost always lies in the palatine arch near its edge.

Lyall and Stahl[111] favor the cervical sinus theory for the cause of branchial anomalies. They feel that there is clear evidence of the high origin of the superficial tissues in the anterior portion of the neck, bounded laterally by the anterior borders of the sterno-mastoid muscles. The cutaneous inner-

vation of this area arises from the same level as that of the major portion of the external ear, which is a known derivative of the second branchial arch. Skin tabs and cartilaginous rests are known to occur in this region; therefore, persistent cervical sinus openings would lie in the lower third of the neck between the anterior borders of the sterno-mastoid muscles. The anomalies which are connected to the skin are controlled by the embryonic position of the cervical sinus, and are thus retained in the lower part of the neck; however, those anomalies with no skin connection are permitted to participate in the movement brought about by the upward growth of the head structures, and are found in the upper third of the neck.

They think that the evidence seems to indicate that the upper portion of complete fistulas arise from the second pharyngeal pouch. The lower portion appears to be derived from a persistent cervical sinus. Consequently, the complete fistula results from the break through of the limiting membrane of the cervical sinus.

Heredity.

H. Bailey[5] says that there are cases on record where the abnormality has been transmitted—usually through the mother; females are affected 3:1; when fistula is unilateral, right side is more often affected.

Vaughn[168] reported four members in the same family, in three generations, as having cervical auricles in conjunction with branchial cleft fistulae. He stated that these were bilateral and were about one-half inch above, and in direct line with the sterno-clavicular joints. He did not probe to exclude an internal opening.

Hyndman and Light[88] report a mother and three of her five children with branchial fistulae (both cervical and aural)—colored, and believe that branchial fistulae may be hereditary and familial, but seem to be inherited only from the mother.

They quote Virchow's archives (1861)—a mother and eight children; a mother and son in three instances; a mother and daughter; two sisters, a brother and a maternal grandmother; aunts in two instances, all having branchial fistulae.

Matas[117] quotes Fischer as having found an hereditary influence in 21 of 232 collected cases, and in three generations of the same family.

Lyall and Stahl[111] say that Ascherson[3] found eight persons in the same family affected with branchial fistulae in three generations. He had one woman with bilateral cervical fistulae; her father, paternal grandfather, brother, brother and a cousin on her father's side, all had bilateral cervical fistulae. In addition, another brother had a cervical appendage.

Cates[28] had a case of a mother with bilateral fistulae auris congenita and bilateral branchial cleft fistulae; two sisters had fistulae auris congenita; one brother was like sisters, and he had a daughter with one ear pit.

Fischer[56] says that the anomaly occurred in three generations from the maternal side: *1.* grandmother; *2.* uncle and aunt; *3.* five of eight children, although the parents were free.

McFarland[120] had one case with bilateral branchial fistulae whose father, paternal grandfather, brother and female cousin on her father's side all had bilateral cervical fistulas. Another brother had a proven branchial appendage.

Sedgwick and Walsh[152] found only one branchial cleft fistula in a series of 20 in which a family history was elicited. In this case, a 25-year-old woman had bilateral fistulae; her father and cousin had similar sinuses in the neck.

Symptoms.

Whitacre[177] and Huizinga[85] produced cough, hoarseness, pulse changes, pallor, sweating, faintness and gastro-intestinal symptoms by probing a branchial cleft fistula. This is thought to be due to irritation of the vagus fibers, due to proximity of the vagus passing behind the fourth arch and the superior laryngeal nerve running close to the arch.

Whitacre[177] proved that his fistula was complete by the appearance of blood at the outer opening and at the lower pole of the tonsil, as well as by the relief of cough by complete extirpation of the fistula.

Heusinger[74] reported one patient would note fragments of bread or water or other fluids escaping at meals.

Shedden[156], of 51 cases studied, noted that pain occurred as a symptom in only three—usually, then with infection.

H. Bailey[5] says in branchial fistulae he finds continual or intermittent, annoying discharge of mucus. He says that those fistulae, with an external orifice, are subject to recurrent attacks of inflammation. The external orifice is ordinarily pinpoint in size; however, it is occasionally large enough for bread crumbs and other particles of food to pass through. He concurs with Whitacre and Huizinga in that the vagus may be in close relation to the fistula. Further, he finds that pinching, probing or injecting the tract may produce vagal symptoms; *i.e.*, cough, palpitation, and intermittent pulse.

J. M. Brown[22] quotes Coplin as saying that stimulation of salivary secretion by mastication sometimes excited secretion from the fistula, even when it did not communicate with the alimentary canal.

Carp[25] reports a case of a five-year-old boy who was cured of a resistant cough of two years' duration by removal of a branchial cleft fistula after tonsillectomy and adenoidectomy had not helped him. He also says that pinching the tract of a fistula, or injecting a diagnostic fluid, have produced irritative vagal symptoms of cough, palpitation, intermittent pulse, hoarseness, pallor and sweating. At operation the fistulous tract was found to be adherent to the vagus nerve. Referred pain may also occur along the sensory fibers. He quotes Dzondi, Heusinger, Fevrier, Dorion and Lilienthal as having similar experiences with cases of external fistulae.

Lilienthal[106] and others[177,178,167] report cough in cases of branchial fistulae; however, here the cough may be due to drainage into the throat rather than due to vagal stimulation.

Baumgartner[10] says that he operated upon an 18-month-old child (similar to Carp's case) whose mother said the baby had asthmatic attacks whenever the fistulous tract stopped draining and became distended. At operation, a nerve fiber was found attached to the tract, extending deep to the carotid

sheath, apparently leading to the vagus nerve. After surgery, however, the child had several mild similar attacks, and was found to be allergic to milk.

Kramer[100] describes a case in which a draining fistula developed three weeks after tonsillectomy (right side). Varying amounts of pus exuded from the cutaneous orifice. She also noted an unpleasant taste in the mouth ascribed to the pus.

Neel and Pemberton[133] report 319 cases of lateral cervical cysts or fistulae. The frequency of symptoms is recorded numerically below:

1. Gradual enlargement of cyst	117
2. Symptoms preceded by or associated with U. R. I.	61
3. Draining sinus	58
4. Pain	53
5. Intermittent swelling	39
6. Rapid enlargement of cyst	26
7. Dysphagia	17
8. Drainage into pharynx (peculiar taste)	16
9. Fever	14
10. Husky voice	6
11. Pressure	6
12. Retraction on swallowing	6
13. Bulging or fullness in floor of mouth or pharynx	5

They say that one patient found that intake of foods, especially liquids, caused an increase in the drainage from the fistula.

Matas[117] quotes Santi and Meinet, "a few drops of milk would escape out of the external orifice while the child nursed." He also quotes Maury, who had cases in which the external orifice frequently became red, sore and inflamed, especially so in some women during the menstrual period.

Hyndman and Light[88] quote Smith as saying that a fistula in a child of three weeks markedly impaired respiration and deglutition.

They had one case which showed nervousness, restlessness, hoarseness and palpitation of the heart on attempt to pass a filiform.

Ward, Hendrick and Chambers[173] had one patient with a complete fistula, who complained that his beer or coffee would

run out through his fistulous tract, and desired repair for that reason.

Fischer[55] quotes a case in Paris in which the child seeped milk from a fistula.

Robitshek[144] reports a case of branchial fistula in which the patient complained of discharge from a small opening on his neck which had persisted as long as he could remember. Sometimes the discharge stopped for two or three days. During this period the throat became irritable and a cough developed. All symptoms were relieved by re-appearance of the discharge at the external opening.

Sedgwick[151] says that branchial fistulae occasionally drain more when the patient has a cold or upper respiratory infection.

N. W. Gill[64] describes a branchial fistula terminating in a tubulodermoid cyst lying posterior to the tonsil.

Williams[179] reports an interesting case of bilateral complete fistulae in which recent hoarseness and dyphagia had developed following cessation of secretion from one side. A mass appeared in the neck on the same side; at surgery, it was found that the patient had developed a thyroid adenoma in addition to the bilateral fistulae.

H. W. Meyer[127] reported a case of swelling associated with an opening in the lower part of the neck from which exuded a foul discharge. When the swelling was squeezed, the patient noticed a bad taste and a bad odor.

Differential Diagnosis.

Bailey[5] says that branchial fistulae occur in females in 3:1 ratio. When the fistula is unilateral, the right side is more often affected.

The fistulae are: *1.* Present at birth; *2.* lower one-third of neck; *3.* lined with columnar epithelium—usually ciliated; *4.* exudes sticky mucus.

Sommer, et al.[159] present three cases of branchial fistula with cervical auricles, one of which had a complete branchial

fistula reaching up to the petrous portion of the temporal bone posterior to the Eustachian tube orifice.

Johns[92] reports a complete right-sided branchial fistula which commenced to drain a yellowish fluid following a right-sided quinsy. X-ray following radio-opaque injection showed the fistula to be complete.

Ward and Hendrick[172] state that fistulae with an opening into the trachea may give rise to an air sac and present the symptoms of a tracheocele; they had one such case.

Incidence.

Rankow and Hanford[143] report an incidence of 1.8 per cent of 160 branchial anomalies (excluding pre-auricular and auricular defects) occurring at Presbyterian Hospital in the last 20 years, to be of first branchial cleft origin. They quote Frazer[58] as saying in 1923 that none had been reported as yet.

Baumgartner[11] found 33 cases of branchial fistula in 20 years at Los Angeles County General Hospital; he says that the incidence of branchial fistula is about one-tenth that of branchial cyst.

Sedgwick[151] says that branchial fistulae occur equally in males and females. These may occur on either side or bilateral, but unilateral is more frequent. The lesion is usually noticed at birth. It is most frequently seen in the lower third of the neck, although occasionally the middle third, or even the upper third may be affected. He reports most fistulae occur in patients under the age of five years.

Sedgwick and Walsh[152] report that of 20 branchial fistulae studied, eight were anterior to the sterno-mastoid muscle in the lower third of the neck; eight were in the middle third of the neck, and one was in the upper third. Two sinuses were situated in the suprasternal notch, and one was below the manubrium.

Hyndman and Light[88] found that 51.8 per cent of fistulae occur on the right side, 31.4 per cent on the left side, and 16.8 per cent were bilateral.

Semken[154] says that complete fistulae are present in one-third of the reported cases.

McLaughlin[123] thinks that complete branchial fistulae are the commonest form, taking origin in close proximity to the tonsil and passing out and downward in the neck.

Diagnosis.

Shedden[156] says that methylene blue has been injected into branchial fistulae in establishing diagnosis. They have been X-rayed following injections of barium, bismuth in oil or lipiodol; molten paraffin has also been employed, which, after hardening, made a good method of locating the tract.

H. Bailey[5] says that three distinct types of branchial fistulae exist: *1.* Complete, with both internal and external openings; *2.* incomplete with external opening only, and *3.* incomplete, with internal opening only.

He found the external opening is in the lower third of the neck opposite the anterior border of the sterno-mastoid in 80 per cent of cases. The inner opening is usually in the region of the tonsil or the fossa of Rosenmuller.

Johnson[93] adds a fourth type of branchial fistula to the three already mentioned. In this, the opening may be closed internally and externally, the intervening portion being patent and remaining buried in the tissues. This may develop into a cyst, which later presents itself in the neck.

A fistula may be present for years without giving serious trouble except for slight discharge. It may heal for a long time, later to open; while healed, it not infrequently becomes infected and has to be opened. Most people seek relief before the age of 30 years.

Kramer[100] reported a case of complete branchial cleft fistula which followed a tonsillectomy. He says that the fistula is well demonstrated by injection of bismuth in oil (however, four days later an abscess developed which was thought to be due to the thickness of the instilled material).

The patient had one hair protruding from the cutaneous orifice, which recurred if removed; two hairs were present

after incision and drainage for the abscess. The patient refused to have surgical extirpation.

J. M. Brown[22] quotes Virchow, who had one case in 1861 in which there were multiple openings at the junction of the sterno-mastoid muscle with the clavicle.

He says that nearly all cysts with fistulae, whether internal or external, are infected to a varying degree. He finds that branchial fistulae with both internal and external openings are uncommon; however, he says that Kleinert reports six cases of this type from Massachusetts General Hospital.

Baumgartner[10] injects methylene blue and then massages the neck and washes it out with water or saline.

Baumgartner and Steindel[11] present a case of bilateral fistula auris congenita and lateral cervical fistula which had been present since birth. These were surgically extirpated.

McLaughlin[123] says that in a complete tract, the external opening can be observed to move upward in the process of swallowing. On turning the head to the opposite side, the subcutaneous tract can usually be palpated as a fibrous cord. Huizinga,[85] following Kramer's idea and at about the same time, injected lipiodol into a branchial cleft fistula to show its size and location.

Kleinert[96] reports six cases of complete branchial cleft fistula occurring at the Massachusetts General Hospital from 1926 to 1931 despite the relative infrequency of this type of fistula.

Leegaard[105] presented 19 cases of branchial cleft fistula. Three of these had concomitant fistula auris congenita.

Semken[154] says that complete fistulae are present in one-third of the reported cases. He also notes that 40 per cent of the patients had been previously operated.

Hyndman and Light[88] report on 90 cases gathered from the literature and 18 additional cases of their own. They say that the orifice of the fistula is frequently surrounded by an areola of brownish discoloration and occasionally by a

small bit of tissue which invariably contains a piece of cartilage. These are known as supernumerary or cervical auricles.

Ward, Hendrick and Chambers[173] present 70 cases, which they divide into three groups: *1.* Upper—from the supra-auricular region to the angle of the jaw, five cases; *2.* middle —from the angle of the jaw to the thyroid cartilage, 45 cases—all seven branchiogenic carcinoma occurred in the middle group; *3.* lower—thyroid cartilage to the clavicle, 20 cases. They had 16 fistulae, 48 cysts, seven branchiogenic carcinomata, and one cylindroma. They found that branchiogenic cysts and fistulae may be *bilateral;* they found six bilateral fistulae and five bilateral cysts. Two cases had a cyst on one side and a fistula on the opposite side. When the cyst and fistula occur on only one side, the left side is affected more often than the right.

Branchial fistulae are of two types: *a.* primary or congenital, and *b.* secondary, which result from drainage of the cyst. Lorenz[109] feels that the secondary type should be called a branchial sinus. They had 20 cases of this type, and further say that fistula auris congenita have no lymphoid tissue around the tract; also suggest that they might be derivatives of the branchial arch rather than the branchial cleft.

A greater percentage of fistulae have an opening along the anterior border of the sterno-mastoid in the lower third of the neck. Occasionally, the opening may be located along the posterior border of the sterno-mastoid muscle. Five of their seven fistulae were complete, the tract extending upward along the anterior border of the sterno-mastoid opening into the pharynx in the region of Rosemuller's pouch just above the tonsil. One patient had two sinus or fistulous tracts on the left side of the neck, one opening in the middle location, and the second just above the clavicle. X-rays, after injection with an opaque substance, demonstrated two distinct tracts, one being superficial.

Ward[172] says that it is extremely important to inject the tract with lipiodol and get X-rays before surgery. A small purse-string suture is used to retain the dye after injection of a local anesthetic.

Ladd and Gross[101] think that secondary infection is the most common complication in branchial cleft sinuses. They doubt the value of X-ray as a reliable means of determining the extent of the tract, due to variation in the caliber of the lumen of the sinuses.

Bland Sutton[19] classifies fistulae as follows: *1.* Complete fistulae; *2.* fistulae opening in the neck, but ending internally in cul-de-sac; *3.* the canal may be closed internally and externally, but an unobliterated segment remains in the neck; *4.* fistulae connected with the pinna; *5.* supernumerary auricles.

MacGuire[112] injects dilute lipiodol foı roentgenogram prior to surgery on branchial fistulae.

The usual course of the complete fistula generally begins at the external skin orifice, extending vertically or slightly diagonally upward, almost parallel with the anterior border of the sterno-mastoid muscle. Its position is under the platysma and the external layer of the middle cervical fascia, and upon the sterno-hyoid and sterno-thyroid muscles. The fistula becomes angulated in the area of the hyoid bone and proceeds into the depths of the pharynx in the space between the external and internal carotid arteries, which lie respectively anteriorly and posteriorly. After crossing over the hypoglossal nerve, it passes under the posterior belly of the digastric muscle and continues over the glossopharyngeal nerve and under the styloglossus muscle to terminate in the pharynx in the region of the tonsillar recess(sinus tonsillaris).

Wooden and Hutchens[180] inject gentian violet in branchial fistulae prior to excision; they inject bismuth in olive oil for roentgenogram. They found that *mastication of a methylene blue tablet brought prompt appearance of the color externally* in cases with complete branchial fistulae.

Christopher[30] injected molten paraffin, stained with methylene blue into a branchial fistula prior to excision; he said this aided ease of excision.

Blassingame[20] gives a history of a seven-year-old girl who

had had a discharging fistula since birth. The outer opening of the fistula was at the anterior border of the sterno-mastoid muscle near the sternal notch on the right side. The fistula would heal, and then break down, depending largely upon the presence or absence of colds and sore throats. She also had a history of recurring attacks of tonsillitis.

M. Miller[120] reported a case of complete branchial fistula in which he injected lipiodol into the interior orifice, and then visualized it outlining the tract and trickling down into the trachea.

Johnson[93] says that an injection of methylene blue will pass into the mouth if the internal opening is patent.

Gilman[65] has suggested an injection of a thin bismuth paste into the sinus, stereoscopic X-rays then reveal the exact location and the extent of the lesion.

Pathology.

Shedden[156] describes complete fistulae, in which there are both inner and outer openings, incomplete outer fistulae and incomplete inner fistulae.

H. Bailey[5] observes that externally blind fistulae are rare; however, examples are stated by Eddowes,[52] Douglas[49] and Patterson.[138]

He further states that branchial fistulae are lined with columnar, ciliated epithelium unless there have been recurrent attacks of infection—then it may be partially denuded. Muscle fibers may be present in the wall of the tract; there is usually an ensheathing layer of lymph-adenoid tissue present.

Johnson[93] says that the second cleft is most commonly involved in branchial fistulae. The sinus from this opens internally into the tonsillar fossa. The third and fourth clefts, less commonly affected, open internally near the sinus pyriformis. The location of the lesion externally is constant; whether it be cyst or fistula, it appears at the anterior border of the sterno-mastoid muscle.

Brown[22] reports two cases in which no mention of lymphoid

tissue surrounding the epithelium was made. These appear to have been cases of fistula auris congenita.

McLaughlin[123] thinks that complete branchial fistulae are the commonest form, originating in close proximity to the tonsil and passing out and downward in the neck. He found the tracts were usually lined with *columnar* epithelium which was frequently of the *ciliated* type.

Heusinger[74] reported one case of branchial fistula in which the internal orifice was large enough to admit the little finger.

Matas[117] reported a case of a blind branchial fistula in which a cervical auricle was also noted.

Ward, Hendrick and Chambers[173] reported several cases of fistula auris congenita. None of these had lymphoid tissue surrounding the tract, suggesting that they might be derivatives of the branchial arch, rather than the branchial cleft. This is further supported by the findings of Miller and Moore,[129] as well as others.

Gaston[62] stresses the presence of lymphoid follicles lying in fairly dense fibrous tissue and surrounding the epithelium as being of great diagnostic importance microscopically.

Ward, et al.[173] had a patient who gave a history of having a cyst of the neck incised and drained three years previously, resulting in a complete fistulous tract with one internal opening into the larynx and a second into the pharynx. Still another case had a fistula which opened into the trachea, and which presented the features of a tracheocele.

They state that branchial fistulae below the level of the hyoid are usually covered with skin, superficial fascia, platysma muscle and the enveloping layer of deep cervical fascia, as they course along the anterior border of the sterno-cleido-mastoid muscle. In passing up the neck it frequently goes over the common carotid artery and between the external and internal carotid and ventral to the IXth and Xth nerves and in close relation to the internal jugular vein. If the fistula is complete, the tract will probably turn medially to enter the pharynx at Rosenmuller's pouch.

Berry[15] reports a case of complete branchial fistula which on pathological examination had an embryonic rest at its lower end containing blood vessels, nerve tissues, striated muscle and connective tissue.

Wooden and Hutchens[180] present a case of bilateral complete branchial fistulae.

Gill[64] says that the inner orifice of a complete branchial fistula is usually in the supratonsillar fossa; however, he says that Blassingame reported a case in which it was actually situated within the tonsil, and Baumgartner described a case in which it was located in the infratonsillar fossa.

M. Miller[130] thinks that if a fistula is present, it should run between the internal and external carotid arteries. He says that the degree of patency of the tract yields either a fistula, a sinus or a cyst.

Treatment.

Shedden[156] mentions some of the older treatments used for branchial fistulae: Injection of iodine, alcohol, caustic potash, trichloracetic acid, mercuric nitrate and croton oil. He states that more than once these substances passed into the throat causing fatal outcome. Electrolytic destruction was tried as early as 1865 by LeFort. Lichtwitz reported a case cured by this method. He says that in 1891 Sachs first suggested surgical extirpation. He feels that today, the treatment of choice is radical removal.

Konig[99] devised an operation for adherent fistulae. By his technique, the duct is dissected out toward the pharynx as far as possible, and then, incising the mucous membrane of the pharynx, the stump is drawn into the throat, so that both ends of the tract are within the pharynx. Meyer[127] uses this technique.

Bailey[5] feels that if the tract shows evidence of infection, it should be treated conservatively for 14 days. He advocates local anesthesia around the orifice, followed by implantation of a purse-string suture, injection of lipiodol, and roentgenogram three to four hours prior to surgery. He uses the

"step-ladder" incision and pulls the tract on through the second incision, so as to facilitate surgical extirpation.

Love[110] advocates complete removal of the tract, but preceding the operation uses fine horse hair purse string sutures around the orifice. These are inserted as close to the orifice as possible and tightened, so as to close the opening. In one to three weeks the tract is distended, transforming it into a cyst, thus facilitating dissection.

Patterson[135] says that Carnoy's solution, diathermy, cautery and electrolysis have all been tried in treatment of branchial fistulae, but all appear to be haphazard, and surgical extirpation seems to him the proper therapy.

Von Hacker[169] in 1897, after dissecting out the external end, pulled a ligature threaded through the eye of a probe into the mouth in complete sinuses. The ligature was then fastened to the portion of the sinus lying free in the neck and the tract invaginated into the pharynx, ligatured and cut off.

Chevers,[29] after injecting 1:40 solution of phenol on two consecutive days (some of which was expectorated) passed silkworm gut dipped in croton oil. This was followed by passing a silver wire electrode and applying galvanic current up to 15 to 20 milliamperes on the skin surface of the fistula. Five months later, there was no evidence of recurrence. He did not feel it was possible to extirpate the lesion completely by surgery.

Hofer[82] describes seven cases in which he used diathermy (electrocoagulation) after passing a fine electrode; he reports all seven cases cured.

McNealy[125] quotes Senn as saying that there is a constance of relation of branchial anomalies to the large cervical vessels; says that this must be kept in mind during operation. He favors a position of the head lower than the body during operation for fear of blocking the air way. He also adds a few drops of hydrogen peroxide to his methylene blue for injection prior to surgery of branchial fistulae.

Cutler and Zollinger[46] report the use of a modified Carnoy's solution for injection as a sclerosing agent to close branchial

fistulae; in five cases the injection was successful. Sloughing of surrounding tissues occurred in only one case, and this was attributed to a failure to inject directly into the fistula.

Matas[117] says that E. Tricomi[166] performed the first operation for a complete branchial fistula.

Ward[172] uses Bailey's step-ladder incision.

Bickham[17] advocates putting a probe into a fistula prior to dissection. He says the upper stump should be inverted by passing a fine dilator through the pharyngeal orifice. He also says that the entire tract may be excised and the opening closed by Lambert sutures within the cervical wound. If the tract is complete, deep drainage is essential. He uses the sterno-cleido-mastoid incision on fistulae.

Dowd[50] presents a case of complete branchial fistula in which he dissected it out over a urethral catheter which was passed through its entire length into the mouth.

Dowd's technique is obviously a desirable one, which would permit easier mobilization of the fistulous tract; however, it certainly will not work in all cases. Few of the fistulous tracts are large enough in diameter to permit the passage of a ureteral catheter throughout their entire length.

Christopher[30] describes the removal of a complete branchial fistula, using the Von Hacker method of closure of the internal orifice.

MacGuire[112] uses Bailey's step-ladder incision for excision of complete branchial fistulae, closing the skin with skin clips, which he removes, one at a time, starting at the end of 48 hours post-operative, to reduce the amount of scarring.

Baumgartner and Steindel[11] presented a case of bilateral fistula auris congenita and lateral cervical fistulae which had been present since birth. These were surgically extirpated.

Berry[15] reports a case of bilateral complete branchial fistulae; one side had previously healed after cautery and injection of iodine by a "country doctor". The other side

drained creamy pus in the throat, and was surgically removed following a tonsillectomy. He injects the sinus tract with modified Carnoy's solution.

Wooden and Hutchens[150] present a case of bilateral complete branchial fistulae which were surgically removed. They used a modification of the Von Hacker method at the pharyngeal orifice. The excision was done following injection of gentian violet into the tract. After the tract had been carefully dissected out almost to the pharyngeal mucosa, a vain search was made for the pharyngeal orifice. The ligated end was forced through the pharyngeal mucosa to a point presumed to be near the natural opening, and it was sutured to the posterior tonsillar pillar. They felt certain that the fistula was of the complete variety, because mastication of a methylene blue tablet brought prompt appearance of the color externally; therefore, they felt obligated to find the pharyngeal orifice. Satisfactory recovery was made on the part of the patient.

Morgan[132] reports one case of a branchial fistula successfully treated by slitting the external orifice and mopping out the fistulous tract with 25 per cent carbolic acid in glycerine. This was obviously a shallow external fistula.

Robitshek[144] reports a case of branchial fistula which was cured by injection of modified Carnoy's solution.

Singleton[157] feels that complete excision of a branchial fistula should be carried out, and recommends that after the tract has been dissected out in the neck and up beneath the jaw a fine wire probe should be passed through the sinus into the mouth; then, by tying the distal end of the sinus to the outer end of the wire and withdrawing the wire out through the mouth, the sac will be inverted and pulled into the mouth, where it can be ligated and cut off flush with the inner surface of the pharynx.

Sedgwick[151] says that complete excision is the treatment of choice for branchial fistulae except in the very young or in the presence of active inflammation. He uses the step-ladder incision. He says that complete fistulae most often end in the fossa of Rosenmuller.

Hall[69] injects lipiodol and uses X-ray on branchial fistulae prior to surgery.

N. W. Gill[64] uses lipiodol injected into fistulae via a urethral catheter to demonstrate the lesion.

Sedgwick and Walsh[152] *do not* routinely invert the divided stump of complete branchial fistulae into the pharynx, yet they maintain that they have had excellent results in their surgical treatment with no evidence of recurrence.

Byars and Anderson[24] feel that surgical excision of branchial fistulae is the treatment of choice, and general anesthesia should be used. They found injection of a half-and-half mixture of methylene blue and hydrogen peroxide into the external orifice, using mild pressure, to be useful in outlining the tract during the dissection. They use a modification of Bailey's step-ladder incision in the course of removal and warn against injury to the cervical branch of the facial nerve during the operation.

Rankow and Hanford[143] utilize a single transverse incision from the midline to the tip of the mastoid process anterior to the sterno-cleido-mastoid muscle, saying that an ellipse was included in the skin incision to encircle the external fistulous opening.

Blassingame[20] reported a complete branchial fistula in which, by injection of methylene blue, the medial end was found to be in the upper pole of the right tonsil. The fistula and the right tonsil were removed intact during the operation. General anesthesia was utilized.

Hunt[87] feels that in branchial fistulae, early operation should be done (in contradistinction to Johnson and others).

Soboroff[158] utilizes Bailey's step-ladder incision in removal of branchial fistulae.

Beck[13] states that if a branchial sinus is injected, he prefers compound tincture of benzoin; however, surgical removal is his treatment of choice. He says that injection may be used at 18 months of age or under.

BRANCHIAL REMNANTS OR APPENDAGES AND CERVICAL AURICLES.

Embryology.

Sommer, et al.[159] agree with Bailey and disagree with Wenglowski. They say that Bailey (in 1933) points out that the existence of cartilaginous cervical auricles in the lower part of the neck cannot be explained according to the views of Wenglowski, who stated that branchial remnants do not occur below the level of the hyoid bone. The cervical auricles are almost certainly of branchial origin.

Meyer:[127] *1.* feels that anything below the hyoid bone is of pharyngo-thymic origin; *2.* says that the lowest limit of apparatus or structures that develop from branchial origin is formed by a line running through the hyoid bone.

Bland Sutton[19] had one case of a supernumerary auricle lying immediately above a branchial cleft fistula (just above the sterno-clavicular articulation) which contained cartilage microscopically identical to that of the ear. He feels that these are due to an excessive development of the primary tuberculum, or it has become pedunculated instead of fusing with the general mass of the pinna.

Nieden and Asbeck[134] reviewed the literature up to 1931 and found between 70 and 80 cases of cervical auricles. They believe that these cartilaginous growths in the neck were observed by the early Greeks, which led Greek sculptors to adorn images of satyrs with horns arising just below the ears.

Matthews[118] says that the cartilaginous rest always occurs between the hyoid bone and the sterno-clavicular joint and along the anterior border of the sterno-mastoid muscle. He reports a case of cartilaginous rest in the neck in conjunction with anomalous malformation of the second thoracic vertebra. He also notes that Heusinger described the first two cases in 1864.

McFarland[120] says that cervical auricles occur much more frequently in the male than in the female. He quotes Siegel as giving the proportions as 76 to 6.

Heredity.

Carp and Stout[26] say that Cawardine reported a branchial "dermoid" in a woman whose mother had "a small tubercle". This patient had accessory abnormalities; a branchial cervical tubercle and an additional antitragus on the same side.

Eddowes[52] reports a case of cervical auricle which was 3 cm. from the midline and 1.5 above the head of the clavicle. She was told that her grandmother "had something like it."

Tilley[165] quotes Evans as having among his patients a family of eight, four of whom had branchial fistulae, and one, an auricular appendage.

V. Lindgren[108] reports a patient with bilateral tumors on the neck from birth, more conspicuous on the left (see Fig. 1). The mother had a similar condition, and like deformities were described for five generations back, including nine individuals, all of whom were female except two. The first four generations had the condition unilaterally and the last generation, consisting of two individuals, had the condition bilaterally. These were felt to be cartilaginous branchial remnants.

Symptoms.

Eddowes[52] reports a case of cervical auricle which moved upward by puckering on deglutition. Occasionally the patient had a foul taste in her mouth.

V. Lindgren[108] reports a case of two prominent tumors, one on each side of the neck, without pain or discomfort and with no history of infection or drainage.

All other authors[19,101,26] who report on this subject simply describe the obvious cervical deformity which forced the patient to request medical attention.

Differential Diagnosis.

Fried[60] presents two cases of sterno-clavicular branchioma which he feels are due to embryonic rests. These involve the brachial plexus, producing pain and finally death.

Fig. 1. Left branchial appendage. (Courtesy of Dr. V. Lindgren.)

Incidence.

Nieden and Asbeck[134] reviewed the literature and found between 70 and 80 cases of cervical auricles. They presented four additional cases.

Lindgren[108] reports one case of bilateral tumor of the neck which proved to be cartilaginous branchial arch remnants. In reviewing the literature, he reports that Ladd and Gross described three cases of cartilaginous rests of the neck and sessile tabs, and that the infrequent reports in the literature mention these conditions as being extremely rare, and more common in males than females, the sex incidence ratio reported to be 2:1.

Pathology.

Ladd and Gross[101] had three cases with cervical cutaneous tabs containing cartilage, but none of these had associated fistulae leading upward in the neck.

Bland Sutton[19] had one case of a supernumerary auricle lying immediately above a branchial cleft fistula (just above the sterno-clavicular articulation) which contained cartilage microscopically identical to that of the ear. He believes that these are due to excessive development of the primary tuberculum, or it has become pedunculated instead of fusing with the general mass of the pinna.

Senn[155] quotes Virchow's case as showing a cystic tumor attached to the sheath of the carotid artery, adjoining which was found a cartilaginous mass resembling cartilage of the ear. Virchow called this an auricular teratoma, but felt it was due to imperfect closure of the branchial clefts.

Roeder[145] reports a case of malignant degeneration of a branchial cleft remnant which showed survival five years after removal of all of the structures from the right side of the neck.

Lindgren[108] had a case of bilateral tumor of the neck consisting of cartilaginous branchial arch remnants with no evidence of a pit, sinus tract or opening through the skin.

Treatment.

Surgical excision of these branchial remnants is the only recommended treatment.

BRANCHIOGENIC CARCINOMA.

Embryology.

Lorenz[109] in 1913 described malignant cervical tumors which he called branchiogenic carcinomas, and was of the opinion that they had origin in aberrant branchial epithelial remnants.

Symptoms.

Hertzler[73] says that branchiogenic carcinoma is attended by severe pain, which is often referred to the ear and may be felt *before* the tumor is discovered.

Ward, Hendrick and Chambers[173] found their cases of branchiogenic carcinoma usually occurred high in the neck, but they state that the lesion may occur anywhere in the neck that branchial rests are found. Their cases varied in age from 39 to 71 years; however, only one was under 50. The symptoms vary with the location. At first, there is an uncomfortable sensation on the involved side which is usually relieved by thrusting the chin forward to release tension on the tumor. As the tumor develops, intermittent and later constant pain ensues. As the cervical or brachial plexus becomes involved, neuritis and eventually paralysis develops. As the tumor grows, dysphagia, dyspnea and perhaps stridor and dysphonia develop. If the tumor is close to the clavicle, vascular disturbances may be noted in the upper extremity (quoted from Lorenz).

Differential Diagnosis.

McWhorter[126] reports 24 cases of epithelial tumors of the neck. He feels that the majority of them are mistakenly diagnosed as Hodgkin's disease, or lymphosarcoma. Most of the tumors lay behind and below the angle of the jaw.

Incidence.

Carp and Stout[26] say that all of their cases of branchiogenic

carcinoma occurred in males above 40; they also state that Veau collected 47 cases in males to one case in females, from a review of the literature. Siegel agreed in the preponderance of the condition in the male sex.

Oliver[136] presents 80 cases of branchiogenic carcinoma. The ratio of males over females was nine to one. The majority of the cases occur between 40 and 70.

McKenty's[122] findings were similar. Only Hertzler[73] reports a predominance of aged females affected, and he quotes no figures.

Schreiner[149] quotes 0.2 per cent of malignancy to be due to tumors of branchiogenic origin. Fourteen of his 16 cases were over 50 years of age.

Crile and Kearns[39] state that prior to 1935, less than 100 cases of branchiogenic carcinoma had been reported. They report an additional 28 cases.

Ward's[172] cases of branchiogenic carcinoma varied in age from 39 to 71 years; however, all were over 50 with one exception.

McKenty[122] presents five cases of branchiogenic carcinoma, all of which had fatal termination after very rapid growth.

Oliver[136] says that all of his cases of branchiogenic carcinoma occurred in males over 40 years of age.

King[94] described one case of his 76 reported, in which a primary squamous cell carcinoma of the lymph nodes of the neck was diagnosed in a 33-year-old man. He says that the tumor showed histological differences from secondary neoplasms.

Perez[140] reviewed the literature up to 1899 and presented six cases of branchiogenic carcinoma.

Diagnosis.

Martin[115] says that the diagnosis of branchiogenic cancer, or malignant branchioma, can rarely be justifiably made,

since the primary lesion of cancer in the mouth or pharynx may remain silent, or of such small size, as to be undemonstrable for a period of several years. This diagnosis is not reasonable, therefore, except after an observation of five years following treatment of cervical tumor. Up to that time, the diagnosis of malignant branchioma must remain tentative only. He says that, insofar as can be determined, adequate proof of malignant branchioma has never been demonstrated. He thinks that adequate proof could only be the demonstration of cancer arising in the walls of a branchial cyst. This proof has since been offered by Ward and Hendrick, and others.

Johnson[93] says that there is question as to whether or not branchial remnants may become malignant.

Bevan[16] cites several examples and states that branchial remnants may be responsible for primary malignancy in the neck.

Pathology.

Patterson[138] says that malignant degeneration of a branchial cleft cyst was first reported by Volkman in 1882. Belk[14] had seen one case and reported ten others in 1927. Herman[72] also had one.

Bevan[16] states that he has seen a number of carcinomata which had been primary in branchial cleft cysts or cell arrests, and gave the histories of two such cases.

Herman[72] reports a case of a patient who had two distinct, separate branchial cleft cysts, proven by microscopic examination. In addition, the patient developed a branchiogenic carcinoma with metastases which caused his demise 15 months after the onset of symptoms. Others[120,14,149,26] have reported additional cases.

Lahey[102] notes that carcinomatous change in branchial cysts is very low in percentage.

Crile and Kearns[39] say that Broders is of the opinion that cervical squamous cell epitheliomas are secondary to an obscure and undiscovered primary lesion.

Crile[41] says that a careful study of 4,500 cases of cancer of the neck (excluding cancer of the thyroid gland) revealed that less than one per cent have secondary foci of cancer in distant organs or tissues. The collar of lymphatics of the neck forms an extraordinary barrier through which cancer rarely penetrates.

Ward[172] found the site of branchiogenic carcinoma usually high in the neck, but states that the condition could occur anywhere that branchial rests are found.

Hudson[84] feels that most so-called branchiogenetic neoplasms are from obscure primaries rather than arising from branchial cysts, although he admits the possibility of their existence.

Schreiner[149] states that autopsy was obtained in four of 16 cases of branchiogenic carcinoma, and no primary focus was located. The balance of the cases showed no primary source on complete clinical examination. He also states that the tumors grow very rapidly, usually causing demise within one year of the onset, regardless of treatment, and found the tumor more common in men.

Warner[174] stresses the fact that with a hard tumor mass anterior to the sterno-mastoid muscle, inferior to the angle of the jaw, and deep to the fascia with pain, primary branchiogenic carcinoma must be considered. He says that the mortality is high and feels that earlier operation is the only possible way of saving the patient.

Lorenz[109] is more hopeful, stating that of five cases, there was no evidence of recurrence after two and one-half postoperative years. He also quotes seven other cases (other authors) with no evidence of recurrence up to five years postoperative. He was quite radical in his surgery, frequently sacrificing the common carotid artery and the vagus nerve.

Cleland and Hanson[33] present seven cases of branchiogenic carcinoma. One died 17 months later (after X-ray therapy and Crile's neck dissection) of volvulus. He had no evidence of recurrence. Another was alive 13 months after X-ray therapy and showed no evidence of recurrence. Another

showed evidence of recurrence three months after X-ray therapy and was receiving further treatment. The balance of the cases were dead in two to 13 months. Ages of patients varied from 51 years to 72 years. They also present eight other cases, three of which were possibly primary branchiogenic carcinoma and the others almost certainly were not.

Hertzler[73] says that Barthelemy and Fairise[8] report a squamous cell carcinoma of the submaxillary gland and comment on varied distribution of tumors of this type. He says that Fredet and Chevassu[59] report a case of carcinoma, epidermoid in character, embedded in the parotid gland.

Larson[104] had one case of branchiogenic cancer.

Christopher[30] states that while branchiogenic carcinoma is rare, it undoubtedly does occur. It has been referred to as "cryptogenic carcinoma".

Jackson[91] says that in two instances, in his series of operations for branchial cleft cyst, malignant change was revealed. He further states that both thyroglossal and branchiogenic fistulous tracts may occur, and may undergo malignant change.

Hicks[78] says that while subjection of impregnated rats to irradiation produces multiple malformations, especially involving tissues of neurogenic type, it does *not* produce neoplastic change.

Hevenor and Clark[75] used the terms "adenolymphoma (papillary cystadenoma lymphomatosum) or branchioma," and stated that origin from rests of branchiogenetic entoderm or heterotopic rests of Eustachian tube or pharyngeal entoderm was the most tenable theory.

Ward, Hendrick and Chambers[173] in 1949, in a study of branchiogenic anomalies, reported seven cases of branchiogenic carcinoma, three of which showed histologic evidence of originating in the cyst wall. They stated that the microscopic findings were those of squamous cell carcinoma, together with a cyst wall thickened and infiltrated with tumor cells or, if small, almost entirely replaced with tumor. The tumor

cells appeared arranged in whorls or branching cords with very little connective tissue stroma. Cell nests with pearl formations could be noted. Usually the tumor was undifferentiated.

Martin[115] on the other hand, in 1948, while granting the theoretical possibility of cancer arising in branchiogenetic cysts, stated that the diagnosis was rarely justifiable, and that the condition was more likely to be secondary to a silent primary lesion in the pharynx or larynx. He doubted the validity of the diagnosis in the cases reported, saying that he had found no definite evidence that any such specific tumor existed, and that the only acceptable proof of such would be the demonstration of cancer actually arising in the wall of a branchiogenic cyst.

In a later communication published in 1950, out of some 225 to 250 cases reported by 34 different authors, Martin[116] found only three in a series of 80 reported by Oliver from Johns Hopkins Laboratory of Surgical Pathology, which presented reasonable evidence of branchiogenic malignancy. He says that such a diagnosis must rest upon the assumption that there was no primary lesion elsewhere; that frequently the first, and for some time, the only manifestation of a silent malignant tumor in the mouth, nasopharynx, pharynx, larynx or even below the clavicle, was a metastasis noted in the neck. If this occurred as a pathological entity, he felt it should be found in the embryologically similar thyroglossal duct cyst, yet no such cases had been reported. Commenting upon the difficulty in pathologically differentiating between metastatic and branchiogenic carcinoma, he stated that a definite diagnosis could not be made on a histologic basis and that the actual existence of branchiogenic carcinoma as a clinical entity was hypothetical.

In a discussion of Hill and Goodof's[79] paper on "Branchiogenic Carcinoma," H. B. Orton says that he has never seen a malignancy of the branchiogenetic type; however, he has seen a thyroglossal duct carcinoma.

Treatment.

Crile and Kearns[39] think that X-ray treatment alone is

inadequate for branchiogenic carcinoma and should be used in conjunction with radical excision. Their longest survival was 12 months following treatment; however, they say Roeder had one patient alive four and one-half years after treatment.

Hudson[84] believes that branchiogenic neoplasms should be treated preferably by use of radium—at any rate, the treatment of choice is other than surgical.

Hicken and Popma[76] and Hunt[87] advise preoperative irradiation to skin tolerance for branchiogenic carcinoma. They then follow with radical surgical excision and give postoperative irradiation into the open wound, and feel that even then, the prognosis is poor.

Crile[42] advocates radical dissection, with block dissection, including the collar of lymphatics for branchiogenic carcinoma. He says that in carcinoma of the neck, the tumor rarely involves the sheath of the carotid artery. The only tissue that must be respected, to the extent of determining the breadth of the excision of the growth is the common or internal carotid artery. He presents his plan of dissection in detail for cancer of the head and neck. His paper was written on the basis of his experience of having done 132 operations of this type. He recommends leaving the wound open and following with X-ray therapy starting the day after operation, and continuing until the wound is healed. He states that this combination treatment may aid in achieving a higher rate of cure.

Hertzler[73] advocates radical surgical removal as indicated whenever it is felt possible in cases of branchiogenic carcinoma. He feels that no other treatment has any effect.

Eigenbrodt[53] reports a single case of branchiogenic carcinoma in which the patient was well two years after operation.

McWhorter[126] agrees with McKenty[122] and Hudson[84] in that treatment, whether by excision or by radiation, is equally unsuccessful, and in most cases the prognosis is bad.

Hill and Goodof[79] report a case in which a branchial cyst

was removed twice before a diagnosis of branchiogenic carcinoma was made at the third operation. This lesion had apparently extended directly to the tonsil. It was finally treated by irradiation upon occurring the fourth time.

CASE HISTORIES.

My personal cases, collected during the past five years, include four branchial cysts and seven branchial fistulae; however, only two of the cysts were excised. One cyst was incised and drained during an acute inflammatory reaction. Two of the fistulae were excised.

Fig. 2. Pathological specimen—branchial cleft cyst.

Case 1. A 21-year-old white male complained of a tumor under the angle of the right jaw of three years' duration. He said that the tumor was first noted immediately after he had undergone tonsillectomy. Since its onset, the size had fluctuated, but in the preceding three months had remained constant. Other than the obvious deformity, his only presenting symptom was that of a sensation of local pressure.

On examination the mass was fluctuant, movable and non-tender. It extended from his hyoid bone posteriorly, to lie immediately under the lobule of the ear. The cystic mass was aspirated to check for the presence of cholesterol crystals. None were identified.

At operation, done under general anesthesia, an incision was made in Langer's lines of cleavage directly over the mass. The external jugular vein was found to overlie the posterior end of the tumor. Removal thereafter was done entirely by blunt dissection. The tumor was found to overlie the common carotid artery and its bifurcation. It also contacted the right cornu of the hyoid bone anteriorly. The cyst was removed intact (see Fig. 2). Pathology report revealed it to be a branchial cleft cyst.

Case 2. An 18-year-old colored male complained of a mass in his left neck of six months' duration. He had no other attendant symptoms aside from the fact that the mass was slowly increasing in size.

On examination, a semi-fluctuant, non-tender, moderately well-fixed mass was noted about 3 cm. below the angle of the left jaw.

Operation followed the same approach noted in Case 1. The mass was located protruding from under the anterior border of the sterno-mastoid muscle. It was partially cystic and partially nodular. The cystic portion was accidentally nicked in blunt dissection, permitting a creamy exudate to roll out. The walls of the cystic portion were so friable as to preclude further loss of the contents of the mass; however, the mass was removed *in toto*. The anterior edge of the mass was found to be quite adherent to the jugular vein. Pathology report showed the specimen to contain a branchial cleft cyst and a lymph node, both showing chronic infection.

Case 3. A 28-year-old white male came into the office complaining of pain in his throat, difficulty and pain on swallowing, together with difficulty of speech, due to a sensation of pressure against his larynx. He had a temperature of 101°, and appeared acutely ill. He gave a history of having had a cyst removed from the left side of his neck two years previously. He also said that he had had one similar previous episode since his surgery, and that he had gained complete relief when his throat suddenly filled with pus.

Examination revealed a scar along the anterior border of his left sterno-mastoid muscle and extreme tenderness just to the left of his left thyroid cartilage. No fluctuance of localization was noted. Indirect laryngoscopy failed to reveal evidence of abnormality.

He was admitted to the hospital and placed on antibiotics as well as local application of compresses of saturated solution of magnesium sulfate. During the first night in the hospital he again had relief of all symptoms by a sudden rush of pus into his throat, apparently due to the spontaneous rupture of a deep abscess in his neck at approximately the level of the larynx. He said he had some coughing at the onset of the rupture. Later, a copy of his previous operative report was obtained. This disclosed that he had had a left branchial cleft cyst, the excision of which was, obviously, incomplete.

Case 4. A 63-year-old white man came into the office with a swelling over the angle of his left jaw, extending approximately 2 cm. below the angle of his jaw. He had a temperature of 99°, and complained of local pain, as well as pain on chewing and opening the mouth. This swelling had followed an upper respiratory infection. He said that for 30 years he had noted a small lump just below the angle of the jaw, which usually increased somewhat in size at the time of upper respiratory infections. All symptoms became progressively worse, despite 36 hours of intensive antibiotic therapy, so he was admitted to the hospital and treatment was continued. Within 72 hours from the onset of therapy, localization became evident, and he was taken to surgery. An incision and drainage produced 30-40 cc. of thick, creamy pus, relieving the symptoms. After

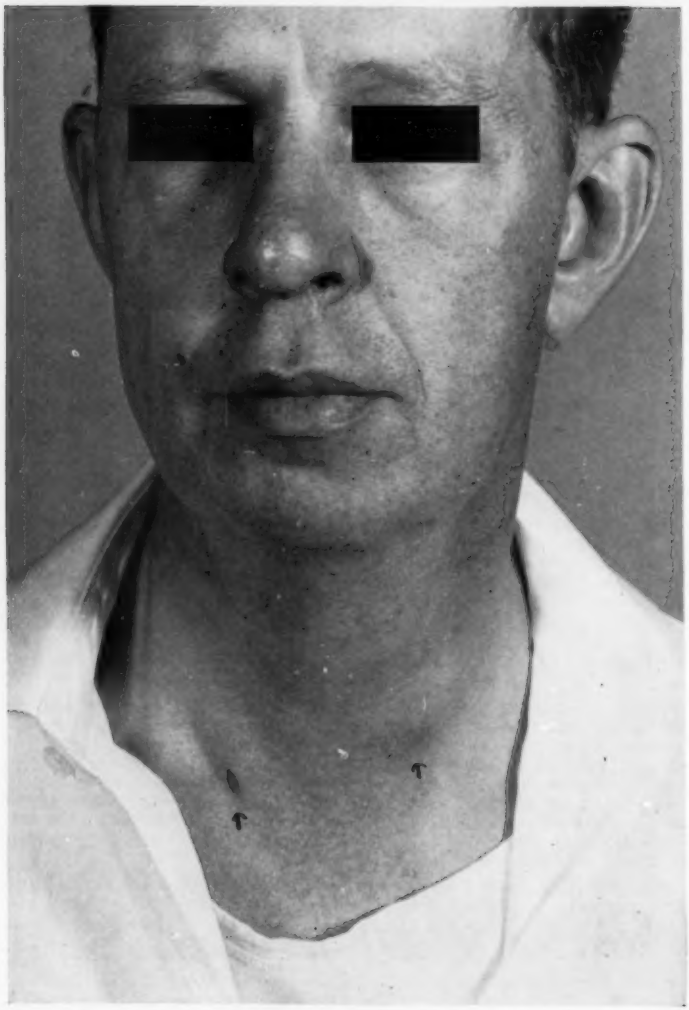

Fig. 3. Bilateral branchial cleft fistulae.

the edema had receded, it became clinically evident that he had a left branchial cleft cyst, which had become infected and formed an abscess, producing his aforementioned symptoms. The clinical diagnosis was confirmed by consultation. At present, he is contemplating surgical excision of the cyst.

Case [illegible] A 21-year-old white woman came into the office complaining of intermittent drainage from the right side of the neck, preceded by local as well as systemic evidence of infection. She said that she had had numerous similar attacks previously. All previous attempts at therapy had consisted of extensive use of sulfonamides or antibiotics. She was desirous of correction of the basic problem.

Examination disclosed multiple fistulae at the anterior border of the sterno-mastoid muscle on the right side, in its middle one-third. A scanty amount of purulent drainage was escaping from the fistulae; however, more of the same material could be produced by pressure on an overlying cystic dilatation.

The multiple fistulae, their tracts and cystic dilatation were excised, utilizing an incision in Langer's lines of cleavage and blunt dissection. The operation was done under general anesthesia, after having injected the tracts with gentian violet to facilitate dissection. The pathology report showed a branchial cleft cyst with multiple fistulae.

Cases 6, 7, 8, 9 and 10. These cases were grouped together, due to the fact that they were all members of the same family.

The first one that I encountered was a 21-year-old white male. He stated that he desired to join the navy, but he had been rejected due to physical defects; further, he would be acceptable to the navy upon correction of the defects. Since birth he had had bilateral fistulae of the neck which exuded small amounts of serous or mucoid material. He also had similar lesions on the anterior portions of his ears. He said that all of the other members of his family, except his mother, had had similar lesions.

Examination revealed bilateral branchial cleft fistulae, as well as bilateral fistula auris congenita. The orifices of the branchial fistulae were identically placed, opposite each other, at the anterior border of the sterno-mastoid muscle, and about 2 cm. above the sterno-clavicular articulation. The orifices of the aural fistulae were marginal helicine in location.

He was taken to surgery, and under general anesthesia the left branchial fistula was injected with gentian violet. In view of the fact that no dye appeared in the mouth the conclusion was reached that the fistula was not complete; therefore, excision was attempted through a single incision in Langer's lines of cleavage, after an elliptical incision had been made around the fistulous orifice. The dissection progressed very well until the tract was almost ready for complete removal, at which time the facial vein was inadvertently nicked. The bleeding was controlled by local pressure while the incision was converted by upward extension along the anterior border of the sterno-mastoid muscle to gain adequate exposure of the vein. When exposure was gained the vein was ligated and the dissection completed.

Two weeks later he was re-admitted to the hospital. During this admission, the right branchial fistula was excised as well as both fistula auris congenita. Gentian violet was injected into each of the tracts, facilitating dissection. This time, however, a considerable amount of the dye was noted in the mouth following the injection, so, after removal of the aural fistulae, the branchial fistula was excised, utilizing Bailey's

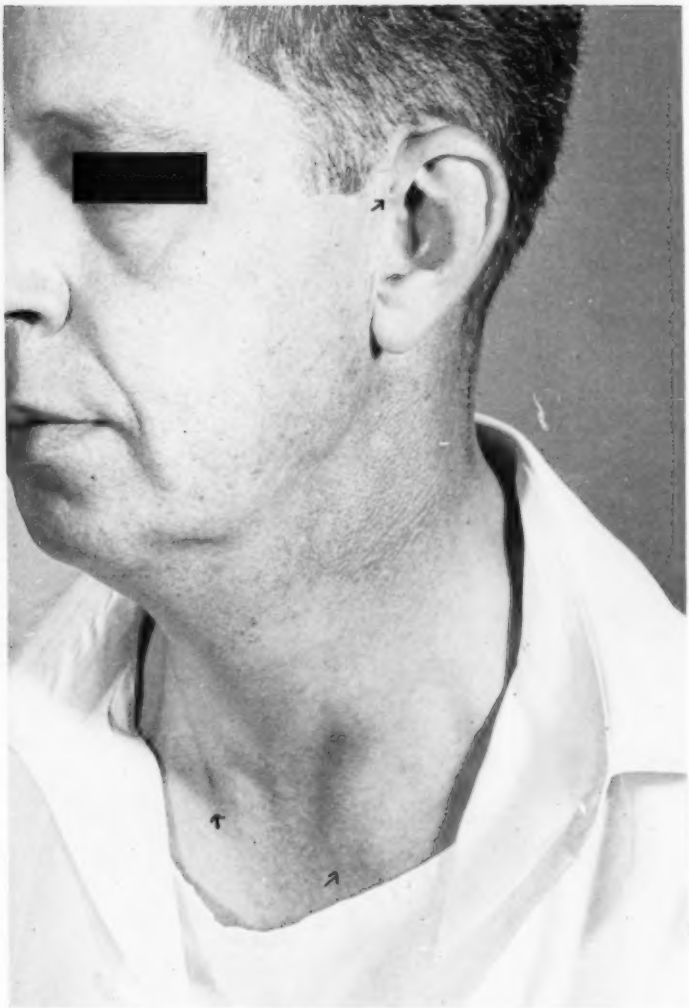

Fig. 4. Left fistula auris congenita. Left branchial cleft fistula.

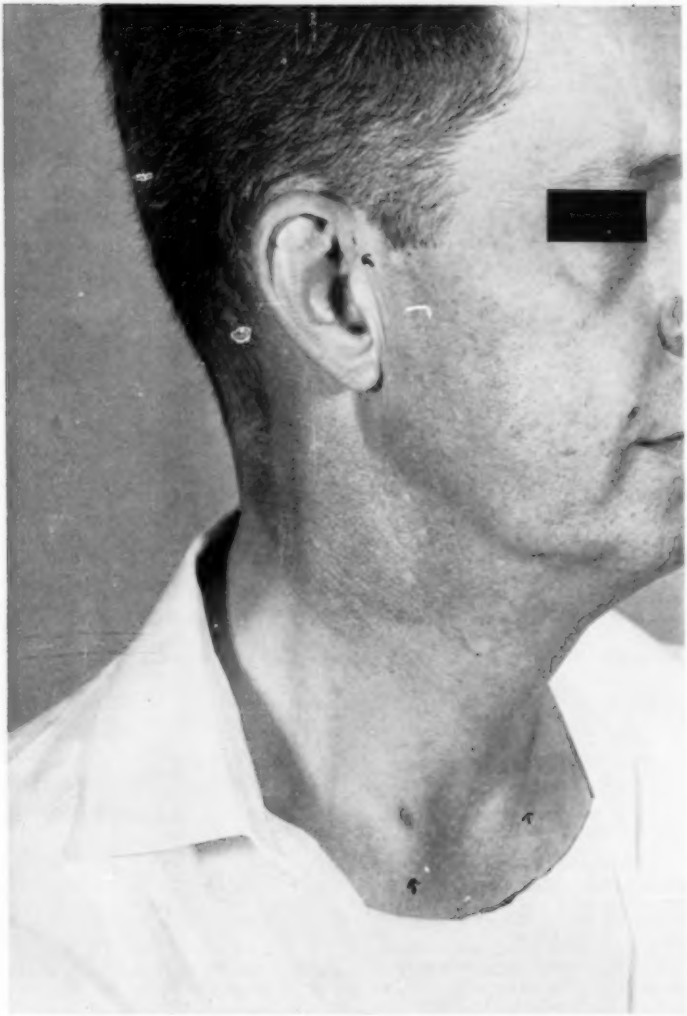

Fig. 5. Right fistula auris congenita. Right branchial cleft fistula.

stair-step incision. The pathology report described branchial cleft fistulae and fistula auris congenita.

Due to the family history, the remaining members were requested to appear for examination.

The father was a 44-year-old man. To the best of his knowledge, no other member of his predecessors had similar lesions. He had bilateral branchial fistulae, as well as bilateral fistula auris congenita. The orifices of the branchial fistulae were in virtually the same position as noted on his son; however, immediately below the right orifice lay another similar opening. The aural fistulae were also marginal helicine.

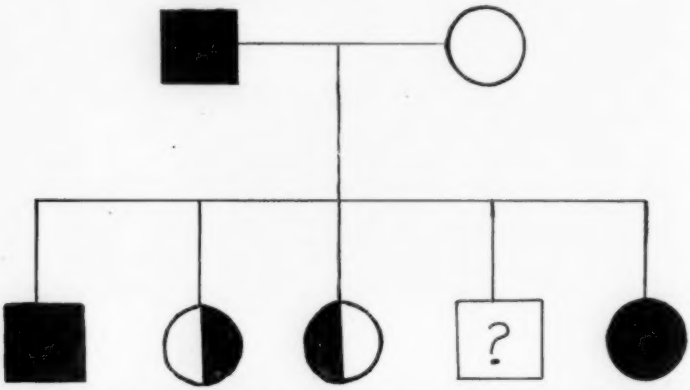

Fig. 6. Father, one son and one daughter had bilateral fistula auris congenita and bilateral branchial cleft fistulae. One daughter had a left aural fistula and a left branchial cleft fistula. One daughter had a right branchial cleft fistula, a right aural fistula and a left branchial cleft cyst. One stillborn son was not examined.

He had had virtually no discharge from the fistulae, consequently he had no desire for surgical excision (see Figs. 3, 4, 5).

One sister was 19 years old. She had a marginal helicine aural fistula on the right side, but none on the left side. She also had bilateral scars on her neck from previous excision of branchial anomalies. According to the history, she had a fistula on the right side and a cyst on the left side.

Another sister, who lived nine days, but would have been 16 years old at the time of examination of the other members of the family, had one aural fistula on the left side and one branchial fistula on the left side.

Another sister who was three and one-half years old, had bilateral marginal helicine aural fistulae as well as bilateral branchial fistulae.

Finally, there was a stillborn baby boy. Unfortunately, adequate examination was not carried out, and no definite statement can be made

regarding his possession of these interesting congenital anomalies (see Fig. 6).*

Case 11. A ten-month-old girl was recently brought into my office because of a draining fistula of the right side of the neck. The mother stated that the fistula had been present since birth. The purulent drainage had first been detected one week previously. No history of hereditary tendency could be elicited.

Examination revealed a small, elliptical orifice on the anterior border of the right sterno-mastoid muscle at the level of the cricoid cartilage. The orifice was congested and edematous. Extending upward and slightly medially, a fibrous "cord" could be palpated to approximately the level of the lower border of the thyro-hyoid membrane. Milking produced a drop of thick, creamy, purulent exudate. The patient was started on antibiotic therapy as well as the use of local compresses of warm magnesium sulfate (saturated solution). The mother was advised that the fistula should be removed; however, this will be deferred at least until the child has reached the age of 18 months.

SUMMARY.

1. An attempt has been made to review all of the available literature on the subject of branchial anomalies, and to provide an accurate bibliography by personal verification of all references.

2. While it was not the intent of the author to become uncompromisingly embroiled in the seething cauldron of embryologic controversy regarding the specific etiology of these interesting cervical anomalies, it appeared that the theory of Wenglowski,[176] despite his many years of painstaking research on the subject, has the least amount of actual support. It seems that all of the other theories, relating the etiology to the branchial apparatus in one manner or another, have considerably more feasible proof.

3. Case 1 represents a branchial cyst in which, as mentioned by other authors,[93,5,121,100] a specific etiologic agent can occasionally be demonstrated. This cyst was first detected immediately following a tonsillectomy. It would, therefore, appear that this represented an internally opening fistula,

*Author's Note: Additional information has been obtained since this thesis was submitted, which further substantiates the hereditary tendency of the transmission of branchial cleft fistulae in conjunction with aural fistulae, at least in the particular family which came to my attention. Case No. 8 has been married and had a baby girl. This baby also has bilateral branchial and bilateral aural fistulae. Two months later, Case No. 6, who had also been married in the interim, also had a baby girl. This baby also has bilateral branchial and bilateral aural fistulae and a deformed left ear.

whose inner orifice was closed by the scarring of the tonsillectomy, consequently permitting its first appearance as a cyst.

4. Two cases (Nos. 3 and 4) of abscess in branchial anomalies were presented. One of these drained spontaneously, internally at approximately the level of the larynx. The other required surgical intervention to facilitate drainage.

5. Despite the recent proclamations of other authors[37] that heredity plays no part in branchial anomalies, an extremely interesting family history is presented, which indicates quite strongly that heredity may play a definitive role, at least in the case of branchial fistulae. This family history becomes more intriguing when one considers the fact that nearly all other histories indicate that the hereditary traits are borne by the maternal side of the family. Only three other authors[111,120,152] have indicated the possibility that the trait might be borne by the paternal member of the family; further, it has been stated by other authors[33] that, unlike other congenital anomalies, fistula auris congenita rarely, if ever, occurs in conjunction with other anomalies. In the case of this family, all members having branchial fistulae also possessed aural fistulae.

6. Although seldom mentioned, multiple fistulous orifices may occur in the case of branchial fistula. Two such cases have been presented.

7. No cases of branchiogenic carcinoma have been observed in this series; however, it seems to the author that this condition may exist, even though extremely rare, as a clinical entity, arising in branchial arrests. This point is substantiated, in part by the single case from Emanuel Hospital, in which squamous cell carcinoma, Grade I, developed in the wall of a thyroglossal cyst. Certainly, it would appear that if carcinoma can develop in one type of embryonic arrest, it could also develop in another (branchial). Care should be taken to check for a primary focus, especially in the nasopharynx, prior to arriving at the final diagnosis.

8. Occasional reports of branchial appendage appear in

literature.[26,101,19,108] All of these reports indicate the extreme rarity of the condition. This is, indeed, borne out by the fact that only four such cases were seen at Emanuel Hospital in the past ten years; however, this represents .154 per cent incidence in our cases of all anomalies of branchial origin. Recently,[107] another such case has been diagnosed, but has not yet undergone surgery for correction of the deformity. This will raise the incidence further. While it is obvious that branchial appendages are rarely seen, it would appear that they occur more frequently than the literature indicates. The condition is said to occur more frequently in males than in females. The expected ratio is 2:1.[173,121,134] Lindgren's[107] recent case, detected in a newborn female, gives us three cases in females and two in males. Obviously no attempt should be made in the way of statistical analysis, based on a series of cases as small as this; however, in view of the relative rarity of the condition and the paucity of reports, these figures would of necessity bear weight out of normal proportion in any attempt at such an analysis.

9. A summary of the branchial anomalies operated at Emanuel Hospital, Portland, Ore., during the last ten years has been presented. The frequency of occurrence of branchial to thyroglossal anomalies seen at Emanuel Hospital during this same period has also been noted.

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POST GRADUATE COURSE IN LARYNGOLOGY AND BRONCHOESOPHAGOLOGY.

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FIBROSARCOMA OF THE LARYNX.*

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Chicago, Ill.

Cancerous tumors in the larynx of connective tissue origin are exceedingly rare in comparison to carcinoma. The recent literature supports this statement, although the early writers had shown an appreciably greater incidence of sarcoma. Confusion in histopathologic diagnosis was apparently the cause of this discrepancy. Ewing[1] concluded most sarcomas of soft parts are derived from specialized tissue cells and that many of the so-called spindle cell sarcomas arise from epithelium. Boyd[2] states that the differentiation of certain forms of carcinoma from sarcoma may be difficult; and in the more anaplastic sarcomas, the type of cell may not be recognized.

In view of these observations and reviewing the experiences of other laryngologists, it would seem that careful study of laryngeal sarcoma should be continued whenever possible, to add to the present knowledge of these tumors, methods of diagnosis, classification, and successful treatment.

The following three patients with laryngeal fibrosarcoma were adult males. Diagnosis was made by laryngoscopic examination and biopsy. Two were treated by laryngectomy, the third, debilitated by severe bronchial asthma and bronchiectasis, received Roentgen therapy.

Case 1. H.E.—This 52-year-old male patient was referred on Sept. 25, 1953, because of a tumor of the larynx which had caused hoarseness of increasing severity for the previous six weeks. Mirror examination of the larynx revealed a large fungating red mass apparently involving both sides of the larynx anteriorly with considerable obstruction of the airway. Because of the size of the tumor, the exact point of origin could not be determined, although it was most prominent on the right side. Small cervical nodes were palpable on the left side under the anterior border of the sternomastoid muscle but none was found on the right. A lateral roentgenogram of the neck for soft tissues revealed the large mass at the glottic level almost filling the laryngeal lumen (see Fig. 1).

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Fig. 1. Case No. 1. Photograph of the lateral roentgenogram of the neck. The large discrete mass (A) almost completely obstructs the larynx.

Direct laryngoscopy was done on Sept. 30. The laryngeal airway was seen to be markedly obstructed, and the mass was observed to arise chiefly from the right true cord and the anterior commissure. In obtaining the biopsy with cup forceps, the tissue was found to be moderately firm and somewhat gritty. Several pieces were removed for biopsy.

The preparation showed the characteristic elongated cells with fibrillar

cytoplasm. Some of the nuclei were deeply stained, others were vesicular. Considerable variation was noted in the size and shape of the cells and some were in mitosis. The histologic diagnosis was fibrosarcoma of the larynx (see Fig. 3).

Because of the size of the lesion and the basic involvement of the laryngeal structures, it was felt that a total laryngectomy would be necessary. The operation was done on Oct. 10, three months after the

Fig. 2. Case No. 1. Photograph of the excised larynx opened in the posterior mid-sagittal plane and illustrating the polypoid sarcoma attached to the right vocal cord and subglottic area near the anterior commissure.

stated onset of symptoms. The surgical specimen included the thyroid and cricoid cartilages, the upper two tracheal rings and the hyoid bone with the strap muscles attached.

Grossly, the tumor was noted as a fleshy gray tissue covered with hyperemic mucosa, attached to the anterior portion of the right true cord ending 5 mm. from the anterior commissure and extending posteriorly 1.5 cm. with 1 cm. elevation. It extended into the ventricle, displacing the false cord upwards. Below the mass on the right cord and continuous with it was a pedunculated, polypoid prolongation of the

tumor extending downward to a length of 2 cm. with an average width of 1 cm. (see Fig. 2).

Histologically, the tissue confirmed the biopsy findings of fibrosarcoma. It consisted of interwoven bands of elongated spindle-shaped cells. In some portions the cells were seen to be less definitely arranged into bands and, in regions with edema, spindle-shaped cells and angulated large mononuclear cells were observed. Among these cells were many in mitosis. The surface edge was a narrow layer of squamous epithelium (see Fig. 3).

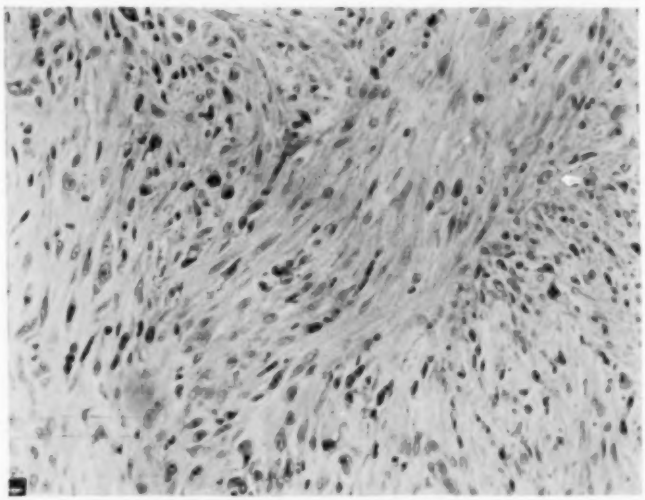

Fig. 3. Case No. 1. Photomicrograph illustrating the bands of spindle-shaped cells in the sarcoma.

The patient was discharged from the hospital Oct. 27, 18 days after surgery. At that time, the operative wound was well healed, the stoma was satisfactory and the swallowing function was good.

Three years following surgery, the patient is well and working every day at his job as an electrician. He has developed a good esophageal voice. No evidence of local recurrence or regional mestastases has been noted.

Case 2. I.S.—This 58-year-old male patient developed hoarseness in May, 1952. A biopsy of the larynx elsewhere had been reported as showing a malignancy, but a definite decision had not been made as to the exact nature of the lesion; however, a course of X-ray therapy had been started with several interruptions and was terminated after two-thirds of the intended dosage had been given; the patient had received a total skin dose of 5000*r*. The hoarseness persisted and in May, 1953, the patient was referred for further study. Mirror examination of the larynx revealed a large nodular mass almost filling the airway. No palpable

nodes were found on either side of the neck. A Roentgen film of the chest showed a moderately enlarged heart but no evidence of pulmonary disease.

A direct laryngoscopic examination was made on May 13, 1953; the mass appeared to be nodular and covered with a grayish exudate, filling two-thirds of the glottic lumen. Several large pieces of the tumor were removed with cup forceps, thus improving the airway and also obtaining material for histologic section.

Fig. 4. Case No. 2. Photograph of the gross specimen illustrating the mass of sarcoma tissue in the left vocal cord and the anterior commissure.

The tissue was noted microscopically to be markedly cellular, mesoblastic and consisted of interwoven bands of elongated, spindle-shaped and angulated cells with fibrillar processes. Among the spindle-shaped and angulated cells were some in mitosis, indicating growth activity. The histologic diagnosis was fibrosarcoma of the larynx.

After consideration of the extent of the lesion and the previous treatment, a total laryngectomy was advised. The operation was done May 26, 1953, following the usual medical survey and clearance for surgery. The surgical specimen consisted of the thyroid and cricoid cartilages including the epiglottis, the hyoid bone and the anterior portion of the upper two rings of the trachea. The strap muscles were sectioned close to their sternal origin and removed with the specimen.

The gross specimen was inspected after splitting the cricoid posterior-

ly. The lining of the larynx was smooth, gray and glistening except for a gray, smooth-surfaced, coarsely lobed polypoid mass in the left ventricle. It began at the level of the anterior commissure and extended posteriorly along the left true cord about 2 cms., and was seen to be elevated 1 cm. In the vertical axis the length was 2 cms. lying in about equal proportions above and below the true cord and displacing the left false cord upwards (see Fig. 4).

Histologic study confirmed the biopsy report of fibrosarcoma (see Fig. 5). Little surface squamous epithelium was noted but, where present, was seen to be narrow and regular.

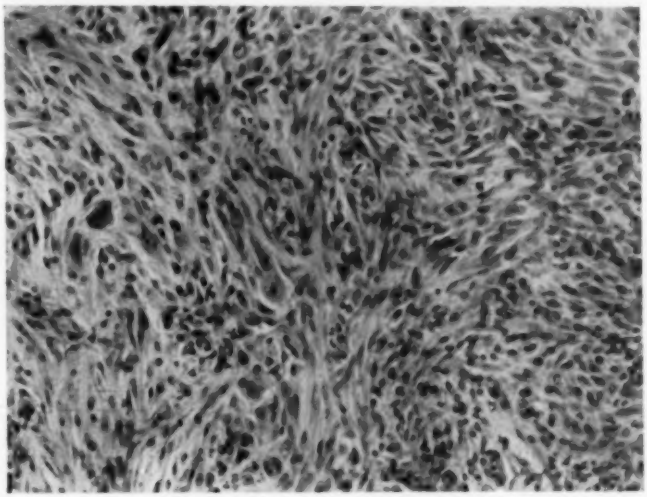

Fig. 5. Case No. 2. Photomicrograph illustrating the bands of spindle-shaped cells in the sarcoma. Note the cell in mitosis near the center of the illustration.

At the termination of surgery, while still on the operating table, the patient developed an acute coronary insufficiency. His condition was extremely precarious for 24 hours following the operation, but he gradually showed improvement during the subsequent three days. On May 30, four days after the laryngectomy, a second and fatal coronary attack occurred and the patient expired. Unfortunately, consent for an autopsy could not be obtained, but gross and microscopic study of the specimen indicated that the entire tumor had been removed.

Case 3. W.W.—This 70-year-old male patient was admitted to the hospital July 14, 1947, with hoarseness of four weeks' duration, chronic productive cough for 20 years and increasing dimness of vision due to bilateral cataracts. Mirror examination of the larynx revealed a normal right cord, but a large red mass with a smooth surface covered the anterior two-thirds of the left true cord. Because of the size of the

tumor it appeared also to involve the anterior portion of the left vocal fold with apparent limitation of motion of the structures on the left side of the larynx including the left arytenoid cartilage.

Direct laryngoscopy was done, at which time several pieces of tumor were removed for biopsy. The cup forceps cut evenly through the tumor with very little bleeding from the cut surfaces. On histologic examination, the tissue was noted to be highly cellular, composed of atypical cells. At some levels they were clearly spindle-shaped, arranged in

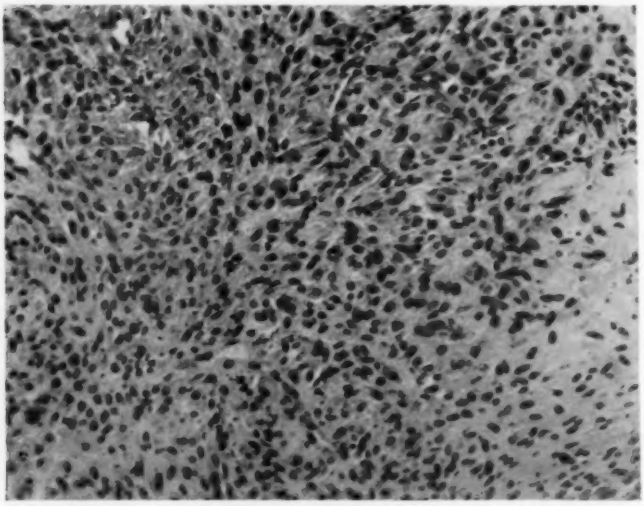

Fig. 6. Case No. 3. Photomicrograph illustrating the cellular structures of fibrosarcoma tissues.

bands. The nuclei were elongated and vesicular with chromatin granules. Portions of these tissues extended to the surface, where cellular granulation tissue was noted. In other portions, the margin had a smooth squamous epithelium.

In some regions, the spindle-cell type was less clearly seen. The cell outlines were not sharp and the interstitial portions seemed to have a fibrillar structure. Among these cells were many in mitosis. The tissue was considered to be mesoblastic in origin and the diagnosis was fibrosarcoma (see Fig. 6).

The patient's general condition was extremely poor. He had a persistent hard cough associated with severe bronchitis and emphysema, with increasing shortness of breath. Chest roentgenograms showed moderately advanced, apparently arrested tuberculosis in the right upper lobe with definite emphysematous changes throughout the remaining lung fields. He had been under the observation of the ophthalmologist since removal of a cataract of the right eye in 1938. Removal of the cataract in the left eye had been indefinitely postponed because of his

pulmonary condition. Surgical removal of the laryngeal tumor was seriously considered, but the general risk and probable postoperative complications of the pulmonary disease seemed to be too great a hazard; consequently, it was agreed that the treatment of choice would be Roentgen therapy.

From July 24, 1947, to October 18, 1947, the patient received 3800*r* in air through an 8 cm. x 8 cm. portal to each lateral neck area. One month after the institution of treatment, the nodule on the left cord had diminished in size. The surface of the lesion was smooth, and superficially it had assumed a cystic appearance. For the remainder of the treatment period little change was noted. At the completion of the Roentgen therapy, the cord was still nodular anteriorly and showed marked redness posteriorly.

Six months following the Roentgen therapy, mirror examination of the larynx revealed an increase in the nodularity on the left cord, indicating a recurrence of growth of the tumor. A second course of therapy was begun on April 4, 1948. A further dose of 1400*r* in air was administered in 10 treatments over a period of seven weeks using only the left lateral laryngeal portal.

On Sept. 18, 1948, four months following the second course of therapy, marked edema of all the laryngeal structures was noted, but no recurrence of gross nodularity of the left cord could be seen. The patient's general condition had deteriorated, and he was admitted to the hospital for general medical care. During the following year he remained at home, a total invalid. No examination of the larynx was made during that time, but verbal reports indicated no apparent change in the laryngeal condition. Death occurred on Sept. 7, 1949, shortly after a fall in which the patient sustained a fracture of his left arm. A post-mortem examination of the larynx had not been obtained.

REVIEW OF THE CASE REPORTS.

Careful study of the surgical specimens of the first two cases in this group support the decision to treat the lesion by laryngectomy. In both instances, considerable subglottic extension was present, but no infiltration beyond the larynx was noted.

It probably would have been advantageous to have operated upon the second patient as initial treatment rather than to administer the course of radiation therapy. The complicating fatal attack of conorary occlusion might possibly have been avoided. One of the obstacles had been the uncertainty as to the true nature of the disease in the original biopsy. Adequate and representative tissue left no doubt as to the diagnosis when the second biopsy was obtained. The third patient, treated with Roentgen therapy, probably could have tolerated a thyrotomy had it not been for his pulmonary complication. Radiation treatment was instituted more as a palliative procedure rather than to obtain a cure. The re-

sponse to therapy was extremely slow and consisted of a regression but not a disappearance of the tumor. At the same time numerous ill effects, both generally and locally, followed treatment. The three year non-recurrence, following radium therapy reported by Figi,[3] supports the proposition that in cases with severe pulmonary complications, his method would be preferable to Roentgen therapy.

DISCUSSION.

The three types of laryngeal sarcoma most commonly reported are fibrosarcoma, lymphosarcoma and chondrosarcoma. This thesis concerns only fibrosarcoma of the larynx. During the ten-year period from 1947-1956 inclusive, no patient with chondrosarcoma was observed. Two patients with lymphosarcoma of the larynx were seen during this time, one with a mass in the left pharyngo-epiglottic fold and an enlarged cervical node at the left carotid bifurcation, and one with involvement of the left true cord. Both responded remarkably to Roentgen therapy, but both later developed sarcoma elsewhere. This delayed complication is a common occurrence in laryngeal lymphosarcoma. The tumor should not be considered as a true sarcoma[4] but rather as a manifestation of a generalized disease; consequently, this discussion has been limited to the fibrosarcomas, the most important and most common primary tumor of the larynx of connective tissue origin.

The rare incidence of fibrosarcoma of the larynx can best be appreciated by comparison with the incidence of other cancerous tumors of the larynx. Figi[3] reported four cases of sarcoma seen at the Mayo clinic from 1910 to 1933; and during that time, 713 cases of laryngeal carcinoma had been observed. Havens and Barkhill[5] reviewed 15 cases of sarcoma from 1934 to 1941. It was estimated from their figures that the ratio of sarcoma to carcinoma is approximately 1:100. Clerf's[6] discussion of sarcoma was based on eight cases treated at Jefferson Hospital from 1930-1946. During that time there were 740 carcinomas. He stated the ratio of the two types of cancerous tumors during that time was 1:92.

In the ten years, 1947-1956, during which the three cases of fibrosarcoma herein reported were observed, 686 cases of carcinoma were seen. Adding the two lymphosarcomas previously mentioned, a ratio of total sarcomas to carcinomas of 1:117 is obtained. The incidence of sarcoma more recently reported is at considerable variances to the earlier figures. Sendziak's[7] 56 sarcomas included in 535 laryngeal cancers compares with Ewing's[8] statement that the approximate ratio of sarcoma to carcinoma was 1:11 (Molinie). In comparing the reported incidence of the earlier writers with the more recent statistics quoted, and conceding a more exact pathologic classification of the tumors in the latter group, it seems reasonable to conclude that the correct ratio of sarcoma to carcinoma is approximately 1:100.

Fibrosarcoma is usually found in the elderly male, although it occurs in both sexes, and no age is excepted. Rigby and Holinger[9] reported a fibrosarcoma of the larynx in an infant seen first at 17 days of age. Initial examination revealed a large mass obstructing the larynx, arising from the left false cord and the left arytenoid. After two weeks' observation, a tracheotomy became necessary. Repeated biopsies failed to reveal the true nature of the tumor. Death occurred at four months of age, and post-mortem studies proved the tumor and its mediastinal metastases to be a fibrosarcoma. Miller[10] successfully treated a fibrosarcoma by laryngectomy in a seven-year-old boy in 1946. Tumor infiltration of the neck muscles necessitated radical surgery in this instance. No evidence of recurrence was noted three years following surgery. The three patients observed in this study were males, each over 50 years of age. This incidence conforms to the age group of nearly all of the previously reported cases.

Hoarseness is usually the presenting symptom, followed by gradually increasing dyspnea as the growth becomes sufficient in size to obstruct the airway. Occasionally dysphagia has been reported as an accompanying symptom, but this should be expected only as a reflection of extensive growth or infiltration of the tumor into the epiglottis or beyond the confines of the larynx. The patient's general condition is

not affected unless infection or metastases complicate the local disease, or increasing dysphagia has caused malnutrition.

Palpable nodes are absent as a rule; and therefore, the presence of enlarged cervical nodes in a laryngeal tumor suggests a carcinoma or a lymphosarcoma. Metastatic growths are rarely found in fibrosarcoma. When the tumor spreads, it does so through the blood vessels or by contiguous infiltration along the fascial planes or muscle fibers. Lymphatic spread is possible but is uncommon. If distant metastases occur, the lungs are most frequently involved.

The tumor may originate in any portion of the larynx, but usually arises from the true cords or the immediate subglottic area.[3] It is a smooth, rounded, reddish mass, often pedunculated and nearly always showing a distinct demarcation from surrounding tissues. The substance of the growth is firm except when necrosis has occurred.

Histologically, the true fibrosarcoma consists of elongated connective tissue cells, which form connective tissue fibers or collagen. The slender reticulum fibers are blackened with silver stains. The cells are spindle-shaped, the nucleus conforming to the shape of the cell. The cytoplasm is usually fibrillar, not granular, and if vacuolated it is considered that the cells have developed retrogressive changes. Mitotic figures are infrequent in the tissues of this kind of tumor.[11] The cells and fibers are characteristically arranged in interwoven bands that extend in various planes (see Fig. 3).

The diagnosis of laryngeal fibrosarcoma depends upon an adequate biopsy of the tumor and the correct interpretation of the histopathology. Careful direct visualization of the larynx is essential in order to evaluate the location and origin of the tumor and at the same time excise representative pieces of tissue for biopsy. As previously mentioned, regional metastatic nodes are rare, and when found contradict the clinical impression of fibrosarcoma. The possibility of fibrosarcoma should be suspected when a vocal cord tumor is found to be smooth and rounded, perhaps pedunculated, and of a firm texture on palpation with the forceps.

Successful treatment depends upon the complete removal

of the tumor with sufficient surrounding tissues to eliminate the possibility of missing local prolongations of the growth. Roentgen therapy has little use since this type of sarcoma in whatever part of the body it may lie, has marked resistance to radiation; however, the possible benefit of some form of radiation treatment should be considered when the patient's general condition prevents any surgical procedure.

Figi[3] concluded that the treatment depends on the size, situation and activity of the tumor. He had satisfactory results in four cases with radical laryngectomy in one, laryngoscopic removal followed by diathermy in another, and surgical removal through a laryngofissure in a third. His fourth case was treated with radium therapy and radon seed implantation without recurrence during three years' observation.

Thyrotomy with removal of the tumor has frequently proved effective.[3,6,12,13,14] In some instances recurrences after such a procedure, as well as the recurrences after radiation therapy, have been successfully treated by total laryngectomy.[15] Consideration of these experiences indicates that the treatment of the laryngeal fibrosarcomas is surgical removal of the tumor, and though it is usually slow to metastasize and grows slowly, the removal must be complete.[6,16]

SUMMARY.

Sarcoma of the larynx is extremely rare, occurring in a ratio approximately one to every 100 cases of laryngeal carcinoma. Of the primary types of sarcoma, fibrosarcoma is most frequently seen. Lymphosarcoma has been excluded from this review since it is not a true sarcoma; although it may be seen as a solitary tumor, it is usually a generalized disease.

In the three cases in this study, only one was essentially uncomplicated. The extent and location of the tumor in that instance was such that adequate removal meant total laryngectomy. The patient has remained well for three years following his surgery. The second patient presented a problem of an increase in the size of the tumor one year after

Roentgen therapy, and also was known to be an unfavorable surgical risk on a cardiac basis. Laryngectomy still seemed to be the treatment of choice. The operation was successfully completed; but an acute coronary insufficiency occurred immediately postoperatively, and the patient died on the fourth day after surgery. The third patient was treated with Roentgen therapy because of his age, 73, and very poor general condition. The tumor seemed to regress and showed no apparent evidence of recurrence of growth for one year, although complete disappearance could not be proven. Death was due to other causes and permission for an autopsy could not be obtained.

It is apparent that in an early localized pedunculated fibrosarcoma of the cord, conservative surgery may be adequate. Resection of the tumor can be successfully accomplished by direct laryngoscopy or by thyrotomy, but with the more extensive lesions laryngectomy is usually the treatment of choice, since in every instance an attempt must be made to remove the lesion completely at the first operation. Since fibrosarcoma of the larynx usually grows slowly and regional metastases are rare, with adequate surgical removal, it is possible to offer a favorable prognosis.

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POSTGRADUATE COURSE

The 43rd Annual Postgraduate Course in Anatomical and Clinical Otolaryngology will be presented by the Indiana University School of Medicine, March 24 to April 5, 1958.

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For information address: Division of Postgraduate Medical Education, Indiana University School of Medicine, Indianapolis 7, Indiana.

AN EVALUATION OF TWO CLINICAL METHODS USED IN DETERMINING THE PRESENCE OF THE RECRUITMENT OF LOUDNESS PHENOMENON.

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and
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Since Pohlman and Kranz[11] first noted the effects of what Fowler[4] later called "recruitment of loudness," the diagnostic value of this phenomenon has become well established, its presence being generally taken as a definite indication of non-conductive type hearing loss. The need for knowing whether recruitment is present in a particular case has led to the development of many clinical procedures for its measurement.[6] Among these have been introduced a group of tests designed to determine indirectly the presence of recruitment by measuring the intensity difference limen (DL) which is, presumably, smaller in ears manifesting recruitment.

The DL tests are of two general types: those which employ periodic variation of the intensity of a pure tone (amplitude modulation), and those which employ two discrete tones which differ in intensity. Experimentation on the differential threshold for intensity has produced widely divergent findings concerning the absolute size of the DL in normal and pathological ears. Hirsh, Palva, and Goodman[7] have recently attempted to account for such differences on the basis of inter-test and intra-test variations.

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In analyzing the most prominent amplitude-modulation techniques, these authors found three different patterns of modulation employed, as well as differences in frequency and sensation level used. Among the two-tone techniques, time interval between, and duration of stimulus tones, were found to vary considerably. These variations, and others which they report, have caused the authors to question the validity of any of the DL tests now in general clinical use, as well as the entire concept of the DL as a measure of recruitment. Results of a study carried out by these authors indicated that the particular technique they used, a two-tone test, did not differentiate conductive and non-conductive hearing loss. The problem of the influence of variations in procedure on test results has been discussed also by Rosenblith and Stevens,[13] who emphasize the necessity for standardization of procedures if measures obtained through these procedures are to be considered comparable.

PURPOSE.

The purpose of the present study was the critical evaluation of the Jerger DL Difference test[9] and the Luscher and Zwislocki DL test[10] in order to determine which was the more sensitive to the presence of recruitment. It was also expected that some insight would be gained regarding the clinical practicability of either of these tests, which were chosen for comparison because they seemed to meet certain criteria deemed desirable in a recruitment test:

1. Both tests are monaural in nature, *i.e.*, they are applicable to patients having decreased hearing sensitivity in both ears.

2. They both take a relatively short time to administer.

3. The listener's task is easily understood.

4. Administration procedure in either test is not complex and is not apt to cause administration errors.

5. The equipment utilized in either test is commercially available.

6. Results of the tests are readily seen and do not involve extensive calculations.

The two tests in question utilize amplitude modulation of a pure tone in measuring the intensity DL. The major difference between them is that in the Luscher and Zwislocki technique, the DL is measured only at 40 db. sensation level; in Jerger's technique, DL's are obtained at sensation levels of 10 db. and 40 db., the score (DL Difference) being the value of the DL at 10 db. minus the value of that at 40 db. Another difference between the two procedures is that Luscher and Zwislocki employ a mean DL—a middle value between an ascending DL and a descending DL; Jerger utilizes only ascending DL's, obtained by gradually increasing the amplitude modulation until the patient signals his awareness of a beat.

PROCEDURE.

Two groups of subjects were used in this study; a normal hearing group and a pathological group, composed of individuals exhibiting normal hearing sensitivity in one ear and a hearing loss in the other. The normal group included 34 female and 13 male subjects, ranging in age from 18 to 49 years, with a mean integral age of 23 years. The pathological group contained seven male and four female subjects, ranging in age from 24 to 65 years, with a mean integral age of 43 years. All pathological subjects, before being tested with the two techniques under comparison, had demonstrated the presence of recruitment at 2000 c.p.s. and/or 4000 c.p.s. on the Fowler test.[4] This test was administered using two audiometers, a Maico D-9 and a Western Electric 6-B, the outputs of which were fed through a cam-operated switch which utilized the interrupter circuits of the audiometers in order to eliminate transients. The switch allowed the tones from the audiometers, whose frequencies were matched by obtaining a Lissajous figure on an oscillograph, to be heard alternately, each for approximately 1.5 seconds with no delay between them. The absence of delay permitted direct comparison of the loudness of the tones by the subjects. A Daven step-attenuator (2 db. per step) was provided to allow

the subject to adjust the loudness of one tone for the purpose of making loudness balances. Not all pathological subjects exhibited "complete" recruitment, but even in those who did not, marked recruitment was evident.

The pertinent variables (2000 or 4000 c.p.s., 10 db. and 40 db. sensation levels, right and left ears) were systematically randomized for presentation to the two groups. A "condition," for convenience, was considered as one combination of these variables, *e.g.*, 4000 c.p.s. at 10 db. sensation level to the right ear. Each condition was presented to each ear a total of eight trials; four trials using an ascending method (changing from no modulation to modulation), and four trials using a descending method (changing from modulation to no modulation). An arithmetric average of the four ascending DL's was recorded as the ascending DL, and similarly for the descending. An average of these two values was recorded as the mean DL. Thus, a total of 64 measures was obtained on each subject, yielding ascending, descending, and mean DL's and DL Differences. The duration of a given condition was five seconds, during which the subject was to decide whether the tone was steady or beating. The beat frequency used was three cycles per second, in accordance with results reported by Riesz[12] and others.

It will be recalled that the goal of the study was to determine which of the two tests was better able to differentiate the ear with recruitment from the normal ear. Available evidence indicates that, in normal ears, the intensity DL has a larger value near threshold than at higher levels.[2,12] This finding has been supported but, as the work of Hirsh, Palva and Goodman indicates, the absolute value of the DL is apparently quite dependent upon the manner in which it is obtained. In impaired ears with recruitment, most measurements have agreed in indicating that the size of the DL is smaller than that of the normal ear, and remains essentially the same size throughout the intensity range, varying slightly with frequency.

Luscher and Zwislocki measured the DL at 40 db. sensation level because they found that at this level the size of the DL was most constant over the frequency range.

Jerger used a somewhat different rationale, based on the fact that the size of the DL in normal ears is larger near threshold than above, but, in impaired ears remains fairly constant in size throughout the intensity range. To the extent that this is true, the difference between the DL at 10 db. sensation level and that at 40 db. sensation level should provide a measure which differentiates normal and recruiting ears.

An important difference between the present study and those of Jerger and Luscher and Zwislocki was the way in which amplitude modulation of the stimulus tones was increased or decreased. In the other studies, amplitude modulation could be changed continuously. In this study, the amplitude modulation unit employed was a component of the Peters SPD/2 audiometer, and did not provide for continuous change; rather, the changes consisted of discrete steps, the size of which increased with increase of the amplitude modulation. In other ways, however, the procedure used closely approximated those of Jerger and Luscher and Zwislocki.

Mean DL's obtained at 40 db. sensation level were employed in the statistical evaluation of results of the Luscher and Zwislocki technique; ascending DL Differences, determined by substracting the value of the ascending DL at 40 db. sensation level from that at 10 db. sensation level, were similarly used for the Jerger technique.

RESULTS AND DISCUSSION.

Normal Group—As was expected on the basis of previous investigations average DL's at 2000 c.p.s. and 4000 c.p.s. were larger at 10 db. sensation level than at 40 db. sensation level, with the latter being less variant ("F" test).* The absolute magnitudes of the average DL's, however, differed noticeably from those reported by others, particularly Doerfler,[3] Jerger,[3] and Riesz[12] (see Table I).

These differences add further support to the previously

*Guilford, J. P.: "Fundamental Statistics in Psychology and Education," p. 224. McGraw-Hill, 1956.

cited contentions of Hirsh, Palva, and Goodman regarding the influence of variations in technique upon DL measurements.

Consideration of possible factors which might have produced such discrepancies led to the conclusion that the cause lay in the difference in method of varying amplitude modulation. Doerfler, Jerger, and Riesz were able to change amplitude modulation continuously; in this study the changes were accomplished in discrete steps: .3, .4, .5, .6, .7, .8, 1.0, 1.5, 2.0, 4.0 and 6.0 db.* These steps are such as to cause overestimation of DL values, the amount of overestima-

TABLE I.

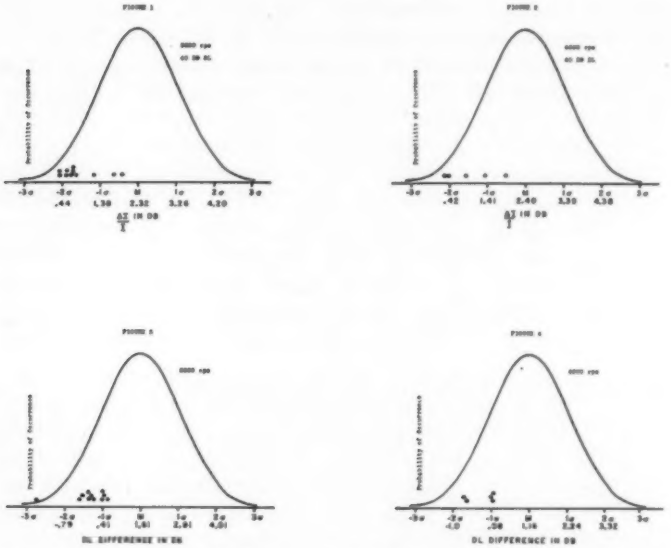
		Doerfler	Riesz	Jerger	Present Study
2000 c.p.s.	10 db. SL DL	1.67	2.40	1.70	3.86
	40 db. SL DL	.81	.75	.83	2.32
	DL Difference	.86	1.65	.87	1.56
4000 c.p.s.	10 db. SL DL	1.20	1.70	1.60	3.54
	40 db. SL DL	.73	.49	.67	2.40
	DL Difference	.47	1.21	.93	1.14

tion increasing as the size of the "true" DL increases. A true DL value falling within any step-interval is recorded as being the upper limit of that interval, regardless of the method of presentation employed. For this reason it was felt that another result of this study, the finding that no significant difference existed between DL's obtained using the ascending method and those using the descending method, was spurious, for the size of the step-intervals did not allow finer differences betwen these two types of measures to be shown.

It can be seen that, as the size of the step-intervals becomes larger, the possibility of greater overestimation of the true size of the DL increases, *e.g.*, a true DL of slightly more than 2 db. would be recorded as 4 db., thus showing a greater discrepancy than would a true DL of slightly more than 1 db., which would be recorded as 1.5 db. It should be noted that any step-wise change in amplitude modulation will have a similar influence on resulting measurements, the contribu-

*Manufacturer's specifications for the Peters SPD/2 Clinical Audiometer.

tion of this type of error decreasing monotonically with size of the step-interval. It follows, then, that such error would be minimized with the use of apparatus permitting continuous change or near-continuous change. This is not to say unequivocally that stepped units have no value, for it would seem logical to assume that if the steps were small enough,



Figs. 1, 2, 3 and 4. Placement of individual pathological DL's (Figs. 1 and 2) and DL Differences (Figs. 3 and 4) in distributions derived from means and standard deviations of a group of 94 normal ears. Each point represents the DL or DL Difference score of an individual pathological subject at the frequency specified on the graph. Vertical position of the points is for convenience in visualizing individual scores along the abscissa and has no significance in terms or ordinate values.

e.g., .1 db., the results would be more indicative of the true DL, and certainly, any measurements obtained with identical apparatus and procedure are comparable among themselves; however, the introduction of any variation in apparatus or procedure increases the probability of arriving at erroneous conclusions based on comparison of such measurements.

Pathological Group—Our interest in the normal group has

been primarily in the establishing of norms against which an ear with recruitment may be measured. In Figs. 1 through 4, Gaussian (normal) distributions have been constructed, using means and standard deviations obtained on 94 normal ears. Each black dot within any of these distributions represents the DL and DL Difference score of an individual pathological subject at 2000 c.p.s. or 4000 c.p.s. Statistical treatment of the *group* pathological data indicated that, on all measures, the mean of this group differed significantly from that of the normal group at the .05 level ("t" test).* Such a result is usually taken to mean that both tests, the DL and DL Difference, had adequately differentiated the two groups; however, a closer examination of this finding reveals that, although it is statistically sound, it does not tell us what we really want to know, *i.e.*, how well do these tests differentiate *individual* normal and recruiting ears in the clinical situation.

The audiologist is confronted by a single individual with a hearing problem, and is obligated to arrive at as accurate a diagnosis as possible in order that further management may be planned and accomplished with confidence. In other words, he must decide, on the basis of the patient's DL or DL Difference measurement, whether or not the symptom of recruitment is present. This means, in effect, that any patient with recruitment must fall either outside the normal (non-recruiting) distribution or so far toward its lower extreme that it is highly improbable that he belongs in that category.

In Figs. 1 through 4 are plotted points representing DL's and DL Differences of patients who had previously demonstrated the presence of recruitment according to a generally acceptable criterion, the Fowler alternate binaural loudness balance test. Inspection of these graphs shows that, as individuals, the pathological subjects have been differentiated from the normal only to a limited extent, in that the pathological scores are distributed along the lower half of the normal distribution, the greatest number being concentrated between -1σ and -2σ. Few values fall between the mean and -1σ and even fewer beyond -2σ. Practically speaking, this

*Guilford, J. P., p. 220, formula (10-6).

means that if each of these patients was seen individually for the purpose of determining the presence of recruitment, as indicated by DL and DL Difference tests, and was diagnosed as having recruitment, on the basis of the statistical findings, this diagnosis would be *incorrect* 5 per cent to 33 per cent of the time for approximately two-thirds of the cases, 33 per cent to 50 per cent of the time for approximately one-sixth, and less than 5 per cent of the time for the remaining one-sixth. A sensitive clinical test, on the other hand, must differentiate the two groups with very little overlap, perhaps 5 per cent (a conventional statistical decision-point). One might conclude, then, that neither of the tests under comparison, at least as defined and used in this study, is clinically adequate. This conclusion is in agreement with that of Ballantyne[1] regarding the Denes and Naunton[2] technique, which served as one of the bases for Jerger's technique.

SUMMARY.

Two clinical methods used in determining the presence of recruitment of loudness were evaluated. These methods were modifications (see text) of the Luscher and Zwislocki DL test and the Jerger DL Difference test. Two groups of subjects, (1) normal hearing and (2) impaired hearing with recruitment, as determined by the Fowler test, were tested using both methods.

The procedure involved the determination of each individual's DL for intensity by the amplitude modulation method at 2000 c.p.s. and 4000 c.p.s. for both ears at sensation levels of 10 db. and 40 db. DL's were measured using ascending and descending methods of presentation. Data thus obtained led to the following conclusions:

1. In agreement with findings often reported, normal intensity DL's were larger at 10 db. sensation level than at 40 db. sensation level, pathological DL's were of lesser magnitude than the normal, and normal DL values varied less at the 40 db. sensation level than at 10 db. sensation level.

2. The exceptionally large normal DL values found in this study may possibly be due to the biasing nature of the discrete-

step amplitude modulation apparatus employed for measurement. Norms were thus found to be too gross for adequate differentiation of the two groups.

3. Graphical examination of the data indicates that neither the modified Luscher and Zwislocki test nor the modified Jerger DL Difference test, as defined and performed in this study, is suitable as a clinical procedure.

4. The need for extensive standardization of apparatus and technique is stressed in order to eliminate variations which may cause clinical inadequacies in comparison of measurements.

The authors are indebted to Dr. Earl D. Schubert of the Cleveland Hearing and Speech Center for his assistance and constructive criticism during the preparation of this paper.

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IN MEMORIAM

HENRY BOYLAN ORTON, M.D.

1886-1957.

Dr. Henry B. Orton, of Newark, N. J., a member of the editorial staff of THE LARYNGOSCOPE since 1939, died in Presbyterian Hospital at Newark, September 1, 1957, of infectious hepatitis. He was 71 years of age.

His work in wide field laryngectomy and deep neck surgery in carcinoma of the larynx brought him international recognition.

Dr. Orton was a past president of the American Laryngological Association and the American Bronchoscopic Society; a member of the Council of the American Laryngological, Rhinological and Otological Society 1948-1950, and served on the American Board of Otolaryngology. He was also a Fellow of the American College of Surgeons.

In 1908, he received his M.D. degree from Jefferson Medical College, Philadelphia, and was professor of laryngeal surgery at New York Polyclinic Medical School and Hospital, attending surgeon at Presbyterian Hospital, as well as consultant at several other hospitals in New Jersey.

During World War I, Dr. Orton served overseas as Captain in the Medical Corps.

His extensive experience in the field of laryngology and bronchoscopy was the source of many articles on these subjects and his contributions to programs of the various otolaryngological societies earned him national repute.

A member of an old and respected Newark family, Dr. Orton maintained an active interest in history, as attested by his membership in the Founders and Patriots of America; Sons of Colonial Wars in the State of New York; Sons of the American Revolution and the New York Historical Society.

His membership in the Essex Club, the Orange Lawn Tennis Club, the Necomen Society and the Essex Country Club of Manchester, Mass., afforded diversion for his leisure hours.

Dr. Orton is survived by his widow, a daughter, and a granddaughter.

THE INTERNATIONAL CONGRESS ON THE EDUCATIONAL TREATMENT OF DEAFNESS.

The University of Manchester Department of Education of the Deaf, will sponsor The International Congress on the Educational Treatment of Deafness, July 15-23, 1958.

The Minister of Education for England and Wales has decided to recognize the Congress as a Short Course which teachers of the deaf may attend under Grant Regulations.

An interesting program has been arranged.

Demonstrations will be given to illustrate some aspects of the research that is in progress in the audiology unit and audiological laboratories of the Department of Education of the Deaf, and in collaboration with the Department of Otolaryngology, the Public Health Department and School Medical Service of the City of Manchester, and the Ear, Nose and Throat Department of the Royal Manchester Children's Hospital. The subjects of the demonstrations will include procedures for the making of screening tests and assessments of the hearing of babies and young children, the results of guidance to parents to enable them to give home training to their children of pre-school age whose hearing is impaired, and the results of an experimental investigation on problems in architectural acoustics that concern the use of hearing aids in school buildings.

Arrangements are being made to offer accommodation to members of the Congress in University Halls of Residence. The cost of this type of accommodation is expected to be about £1. 2s. od. per day, including bed, breakfast and dinner. The University refectory will be available for meals during each day.

For those members who wish to do so, arrangements will be made to visit audiology clinics and special schools in London, Oxford and other places. In connection with the Congress it is hoped to organize tours to places of interest. The dates proposed for this are July 9th, 10th, and 11th.

For further details write: Prof. A. W. G. Ewing, Department of Education of the Deaf, The University, Manchester 13, England.

THE 11TH CONGRESS OF THE INTERNATIONAL ASSOCIATION OF LOGOPEDICS AND PHONIATRICS.

The 11th Congress of the International Association of Logopedics and Phoniatrics will take place in London, August 17-22, 1959. The following official reports will be presented: The Inheritance of Voice and Speech Disorders, Prof. R. Luchsinger, M.D., Zürich; Defects of Articulation, Muriel Morley, B.Sc., F.C.S.T., Newcastle; The Physiology and Pathology of the Soft Palate, Prof. Lucio Croatto, M.D., Padua. The official languages of the Conference will be: English, French, and German.

Those working in the field of Speech and Voice Therapy and all who are interested in this specialty are invited to attend and to submit papers.

If intending to be present, whether submitting a paper or not, please inform the Congress Secretary at the earliest possible date.

Papers are invited on subjects relevant to the three main reports or any other aspect of speech and voice. Only one contribution will be accepted from any one member of the Congress and this must not have been previously published. The Committee reserves the right to select papers. Papers should be restricted to 15 minutes in length; demonstrations to 10 minutes. In special cases 20 minutes may be allowed for a paper of great importance but only if application is made at the time of submitting the title. Should a group of four or more people wish to present a symposium or a prepared discussion on a theme, consideration will be given to allocating up to one hour for such a contribution.

Titles must be received by September, 1958. Summaries must be received not later than November 15th, 1958.

All communications are to be sent to: Peggy Carter, L.C.S.T., 46 Canonbury Square, London, N. 1.

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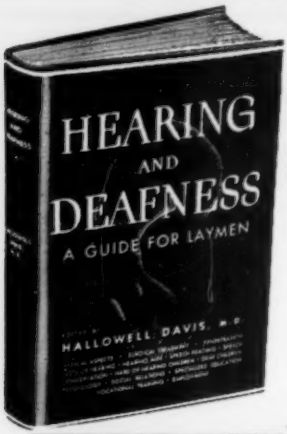

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VOLUME LXVII NOVEMBER, 1957 NUMBER 11

CONTENTS

REVIEW OF THE AVAILABLE LITERATURE OF THE PHARYNX AND PHARYNGEAL SURGERY FOR 1956. Francis E. LeJeune, M.D.; Mercer Lynch, M.D., and Miles Lewis, M.D., New Orleans, La. 1075

TRACHEOSTOMY. V. Negus, M.S., London, England - - - - - - 1098

DECREASED BIO-ELECTRIC POTENTIALS IN THE EARS OF SENILE GUINEA PIGS. G. Pestalozza, M.D.; H. Davis, M.D.; D. H. Eldredge, M.D.; W. P. Covell, M.D., and J. B. Rogers, M.D., St. Louis, Mo. - 1113

BRANCHIAL CLEFT CYSTS, FISTULAE AND APPENDAGES. Jack B. Miller, M.D., Portland, Ore. - - - - - - - - - - - - - 1123

FIBROSARCOMA OF THE LARYNX. Kenneth C. Johnston, M.D., Chicago, Ill. - 1194

AN EVALUATION OF TWO CLINICAL METHODS USED IN DETERMINING THE PRESENCE OF THE RECRUITMENT OF LOUDNESS PHENOMENON. Barry S. Elpern, M.S., Cleveland, Ohio, and Aubrey Epstein, Ph.D., Pittsburgh, Pa. - - - - - - - - - - - - - 1208

IN MEMORIAM. Henry Boylan Orton, M.D. - - - - - - - - - 1218

DIRECTORY OF OTOLARYNGOLOGIC SOCIETIES - - - - - - - - - 1221